CORNWALL: ITS MINES AND MINERS ; WITH SKETCHES OF SCENERY ;...

John R. Leifchild

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ITS MINES AND MINERS.

WITH SKETCHES OF SCENERY.

DESIGNED AS A

POPULAR INTRODUCTION TO METALLIC MINES.

BY THE AUTHOR OF

"OUR COAL AND OUR COAL-PITS; THE PEOPLE IN THEM, AND THE SCENES AROUND THEM."

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SUMMARY OF CONTENTS.

PREFATORY OBSERVATIONS.

THE very favourable reception which my previous volume, entitled "Our Coal and our Coal Pits," &c., has met with at the hands of the press and the public, has induced me to prepare the present work, which will in some measure be a companion to it; as it does for Cornwall, its mines and miners, what the former accomplished for Newcastle, its collieries and colliers.* If similar success should attend this volume, I may be disposed to attempt another, which would include a similar treatment of the miscellaneous metals—as iron, lead, &c., and notices of the gold discoveries in Britain.

In this volume, copper and tin are chiefly treated of, as the Cornish produce consists mainly of those metals; but slight notices of others are added. It has been estimated, that of copper Cornwall yields one-third, and of tin nine-tenths, of the whole supply of the British Islands, and of all European continental countries.

* While these pages are passing through the press, a Government Inspector of mines, Herbert Mackworth, Esq., thus writes to me—"I have been so much pleased with your book on the Coal Pits of the North of England, that I sent several copies to engineers on the Continent, as giving the most complete and accurate account of a part of our colliery population," &c. &c. Mr. Mackworth has sent me a copy of a favourable review of the book, which appeared in the "Journal of Mining, Smelting and Saltworks, in the Prussian States," Berlin, 1853.

This book has the same twofold character as the previous one. It attempts to combine the popular with the informing style —the light with the solid; but instruction is the main object. Considerable pains have been taken to present such a view of metallic mining as would interest the intelligent reader. Nor is the information conveyed to be regarded as altogether *superficial;* for (not to pun upon the word) much of it has a different character, and the volume, when attentively perused, will, I believe, furnish an amount of real information on these subjects, which the reader cannot obtain elsewhere in a similar form or compass. The inquiry and research necessary for this little volume, if expended on other subjects, might have produced a large book. But, for the very reason that such information is not easily accessible, this little book may be the more welcome and useful. It is hoped that, together with the preceding volume, it may be serviceable also for educational purposes, and find its way into mining and other schools of a high character. These little books may also serve as guides for inquiring visiters to such institutions as the Government Geological Museum, in Jermyn-street—the models and minerals of which will be much better appreciated by those who have previously read on the subject. In this book some information is introduced relating to the reduction and manufacture of the metals, and statistical statements are given, in order that the whole may be as generally complete as the author can make it. It will thus be seen that the work is not designed to be merely ephemeral.

When this work was first undertaken, mining speculation was very much afloat. It has therefore been the aim of the author to show the frequent hollowness of such speculations; and to no class is the information of a scientific character contained herein more necessary than to speculators, who are commonly altogether ignorant of mining as a science. The present course of political affairs has exploded many bubbles; but the speculating spirit may return with peace. The mines selected for in-

formation are chiefly the old and non-speculative mines; others have been purposely avoided. The author has no interest in any mines, and writes without bias. He merely endeavours to prevent loss by grave information and light illustration.

A glance at the summary of contents will show that the topics are varied. Barren and unproductive as Cornwall is in many respects, yet it would be difficult to select another English county from which so much interest and entertainment may be derived for an intelligent reader. There is, I believe, no other book on that county having the same object as the present. Although the chief subject of the book is mining, yet antiquities, natural and national, lingual, local, and mineral; the wild Cornish granite moors, with their weird scenery, and innumerable blocks and pillars; the bold coasts, and high bluff headlands; the boundless ocean, with its unfailing shoals of pilchards; the rough, weather-beaten fishermen, and the wan, mine-beaten miners, with their manners, and families, and cottages, and earnings;—all these points which have engaged our attention will, it is hoped, prove as interesting to the reader as they have been to the writer. In a word, in and around the mines I have observed and gathered all the information, metallic, mechanical, and scientific, I could put together in so small a space.

The books of which I have made more or less use are named below, to indicate some sources of detailed information, and to save frequent reference.*

* Dr. Ure's Dictionary of Arts, Manufactures, and Mines, fourth edition, 1853; Transactions of the Royal Geological Society of Cornwall, vol. 5, 1843; Sir Henry De la Beche's Report on the Geology of Cornwall and Devon, 1839; Manufactures in Metal, Cabinet Cyclopædia; Phillips' Geology, Cabinet Cyclopædia; Records of the School of Mines, vol. 1, part iv., by Mr. Robert Hunt, 1853; Rambles beyond Railways, by Mr. Collins; Watson's Compendium of British Mining, 1843 (for private circulation); The Mining Journal, and several periodicals.

I ought, however, to warn the student, that, even with the above works at his side, he will incur much toil and frequent disappointment in searching for precise and recent information on many points of mining interest; and he must often resort to personal inquiry and research.

When the information is obtained with so much difficulty, and from so many sources, often scrap by scrap, any errors that may be discovered will be readily pardoned; and I shall be thankful for any corrections and additions that may be addressed to me through my publishers.

I shall be particularly grateful for the communication of interesting facts connected with the mining of iron, lead, and other metals not treated of in this volume; and also of striking features in the history and working of particular mines of such metals.

J. R. L.

LONDON, 1854.

CORNWALL: ITS MINES AND MINERS.

CORNWALL: A CORNISH VAN, AND JOURNEY THEREBY.

CORNWALL has been, perhaps, less known and visited by tourists than any other of our counties; and, I might say, less than the capitals of the Continent of Europe. You will find in any miscellaneous company, many more Englishmen who have visited Paris than Truro; many more who have sailed up and down the Rhine than up or down the rivers Tamar* and Fowey; many more who know the outside and inside of St. Peter's at Rome, than the outside or inside, especially the latter, of a Cornish copper mine.

The reason is to be found, not so much in the remoteness of Cornwall from the common route, as in the character of the county itself. It is neither a remarkable agricultural or manufacturing county. Its foreign commerce is of very limited extent; its shipbuilding is confined; it has no coal under its soil; and but little iron. Its means of inland communication by railways and canals have hitherto been very scanty. It has, however, that which distinguishes it from all other English

* The Tamar, though classed as a Devonshire river, may be considered almost equally Cornish, as it separates Cornwall from Devon for nearly its whole course. Here I would observe, that, though speaking chiefly of Cornwall, I shall refer to Devonshire mines and to many facts connected with them. The mining localities of the two counties may be considered as one large district.

counties, an immense subterranean repository of copper and tin. All who are interested in copper and tin, and their manufactures, are interested in Cornwall. In addition, I hope to shew that there are many localities and objects of scenic interest. And, if the reader will follow me attentively through this little book, I think he will confess that what, with copper and tin, and the various processes of mining and reducing them; what, with picturesque coast views, pilchards and fisheries, rocking-stones and stones innumerable, steam and steam engines, antiquities mute and antiquities lingual, moors and mountains, minerals, miners, and manners, travelling scenes and travelling companions; what, with all these, I think the reader will confess that considerably more entertainment and instruction are to be obtained from Cornwall than he had previously conceived.

Cornwall is now easy of access. There is a railway direct from London to Plymouth; and every morning one of the fastest mail-coaches in the kingdom leaves Plymouth for Falmouth, as also do two four-horse omnibuses. It is but recently that public railways have laid down their iron network in this county. Now its retired character and remote privacy, bid fair to give way to the unromantic enterprise of civil engineers. At this very time we hear of the Cornwall Railway, and its wonderful progress, under the iron energy of Brunel. A great bridge is to be erected at Saltash passage; an immense cylinder is about to be sunk, in order to contain the pier of the bridge. The estimated weight of this cylinder, with its included ballast, is no less than 340 tons. At last, then, Cornwall is to become famous for marvels of engineering skill. I confess, that on this very account it loses somewhat of its charms for me. I never enjoyed any mode of travelling so much as that of the genuine old Cornish van. I shall therefore convey the reader, together with myself, in such a vehicle. I prefer to go back a few years. I am not writing a "Guide to Cornwall;" such things there are, and such a thing this book is not—it gives no information on posting-houses or horses, on trains or hotels, on breakfasts and dinners, on waiters and inn-bills. It does, however, show how two humble tourists, having an eye for mines, men, manners, and

scenery, went through the county to the Land's End; and what one of the two observed, and, in process of time, accumulated on such topics, for the benefit of the present reader.

Determining to see the county in the most pleasing manner, we adopted a very indirect course, and employed, as far as we could, the peculiar county vehicle—the van. We first crossed the Torpoint Ferry from Plymouth. This ferry is a large floating bridge, worked by steam-power, often conveying 100 people besides vehicles.

Then, in a regular Cornish van, we started for Looe, where we arrived at last, as Virgil says:—

"Per varios casus, per tot díscrimína rerum."

Now, the Cornish van is a conveyance both peculiar and interesting. This particular one was a fine specimen of the kind, although in indifferent preservation; therefore I shall describe it. It resembled very nearly an ordinary covered cart of some length, and was furnished in every direction with a number of primitive appendages for the attachment and support of luggage, and in many respects it might have been termed a "luggage van." To look at it when unloaded, you would have thought its capabilities not very great. Then to look at the luggage gradually being gathered around it, carried up out of the ferry-boat, dragged up by old and young women, and deposited at its wheels, you would have exclaimed, "There must be another conveyance coming up"—not so, however. Imagine yourself with us. A lad comes lazily up from the inn; he looks very complacently at the gathered mass of boxes, hampers, sacks, bags, earthenware, and small parcels. They form altogether about three loads for the outside of any vehicle of the size of this van. Then the lad commences piling and adjusting, and whistling and groaning, and it is perfectly wonderful to behold the way in which he disposes of the whole. On the roof, packages on packages are piled like Pelion on Ossa, until none but the offspring of veritable Titans would seem able to pile any more. I begin to calculate the direction of the line of the centre of gravity, and fancy that it falls without the base

of the van, which condition must lead to an upset, but higher and higher the lad piles, as if he were singing "*Excelsior!*"

And now he descends; the roof will bear no more, another parcel would surely break it down. What will he do with the remainder? He lets down a rack behind the van, and there he piles a tolerable stock in trade for a jack-of-all-trades. But a large number of things still remain. What can he now do? Why, he pulls out of his pocket a few yards of cord, and ties half-a-score of things *under* the van, until there seems to be a sufficient load of pendulous parcels. Well, now he is completely nonplussed, for there still lie on the ground two small casks of chemicals or comedibles, three long boxes of candles or soaps, seven band-boxes and five wicker hand-baskets, with about a dozen large coats, cloaks, and wrappers for passengers; and, just as we are talking and gazing, up comes a carboy in hamper and straw, and seeming like vitriol. However, the lad is not daunted; he whistles rather slowly, and stares a few minutes, and then in he dives into the interior of the van, and in after him go all the aforesaid articles, while the top of the carboy peeps out with a very vitriolic aspect just in front. Well done, lad!

This work (wonderful work, if repeated daily) is done. That lad must have the bump of *order* as big as the carboy! But he does not seem to think he has done any thing unusual, and he saunters again towards the inn. Again he appears with a poor old hack of a horse, and only *one*. The poor beast seemed to give one despairing look at the van, whereupon I observed the lad instantly and considerately turned the animal's head in another direction. When backed in, and lashed to the shafts, the horse seemed motionless as the Duke of Wellington's horse on the arch in the Park. I never expected to see him move any more.

The passengers are now hailed, and directed to get in—"Get in! But how? but where?" Hereupon the lad helps the females in first, and they are navigated up to the top or end of the van. Up come more females with two children. In they go; we hear the children scream—but it is in vain. Now, in go a very respectable-looking young man, (not myself,) but one whom I afterwards found to be a customs officer at Looe, and two common men.

I and my friend reserve ourselves most obstinately until last, in order to get near the open end. My friend *must* now get in, and I too. Finally I found myself privileged with a sharp cutting seat on the ledge, breast to horse, and back to the carboy of supposed vitriol. I gave a look behind to scan the inmates and found *eleven* mortal beings and two children, besides a baby somewhere in the dark. The head of one man, who was tall, touched the roof without his hat. He scarcely moved, and for a forcible reason, the whole journey. The custom-house official was sitting astride over two small casks and one bandbox, and a friend of his had already received charge of one of the screaming children. After this I preferred to look straight forward; I had seen enough behind me.

I fully expected the lad would drive; but the proprietor of the van now made *her* appearance, and *she* was driver. The said proprietor was an old woman of uncommon activity, named "Beccy." Beccy surveyed the loaded van with perfect composure; and, when asked to ascend and occupy her post of duty, she did ascend like a cat. I asked her where she would sit (thinking of the carboy), when she declared she could sit any where, and it certainly was difficult to say where she did sit and could *not* sit; for it was neither on the shafts nor the driver's board that she was mounted, but somewhere between them, and upon them both occasionally. Most certainly she displaced neither passenger nor parcel, and therefore lost neither fare nor fee by her presence. At one moment she was on the yard of board called the "box seat," at another (when I shifted) on the top of the carboy, and at another on the shaft. Often she would walk, and always she would talk. Unfortunately for us, she had lost three pounds of butter in crossing the Torpoint Ferry, and she felt it her duty to explain most minutely how this occurred, to every passenger three times, and once or more to every innkeeper or acquaintance on the road, until it became a general wish that the butter had found its way, in a three-pound lump, into her mouth rather than to the bottom of the sea. Let us walk and talk up this hill.

Before we proceed in our journey, let me say a few words on

vans in general in the county, having said so much of this one. Vans of this description, until recently, opened a communication with nearly all the towns of Cornwall, traversing it in nearly every direction, so that you could feel sure of getting on by them from one seat of business to another. Some of them started from Torpoint for Bodmin by way of Liskeard, and thus made up a two days' or longer passage to Truro. They carried but few passengers to the entire length of their journey, but set them down and took them up in short and quick succession, at various towns or villages upon the route. By their licence they were bound not to exceed a fixed speed, generally of three or four miles per hour, or at that rate between their extreme limits. This rule allowed them to stop often and long, if they pleased, for the convenience of those customers who had an object in travelling, and the great inconvenience of those who had not. In cross roads the vans were none of the most comfortable; but in routes between neighbouring towns of note, as in that between St. Austell and Truro, they were really more than tolerable conveyances, and a keen opposition kept them up to the mark in character, and down to the mark in fares. As to the fares, it was only remarkable that they could be made remunerative. In the much traversed routes they had two horses, and in such parts the fares were lowest. I have travelled by a two-horse van for fourteen miles for one shilling; and even in the out-of-the-way districts this distance might be travelled over for 1*s.* 6*d.* or 2*s.*, by a one-horse van. On market-days whole rows of these vehicles might have been observed, ranged in the market-places; and, where opposition was rife, a sturdy wrangling was encountered before you could reach your seat in the proper van. Such conveyances, systematically arranged so as to traverse all the great lines of traffic, were, I believe, peculiar to Cornwall. In these vans I have met gentry, officials, farmers, miners, innkeepers, travellers on business, and specimens of all the trades and callings in Cornwall. The people patronised the vans to such an extent that short-running coaches were few. As railways are now introduced into this county, vans may be regarded as finished, or "driven off the road." Indeed the van to Looe may be con-

sidered as nearly the only remaining van, properly so called, on the Cornish roads.

THE VAN CONTINUED, UPSET AND ARRIVAL.

Once more I resume my seat, backed by the carboy and confronted by the horse's tail. Beccy sits on my right, and the excise-officer on my left. The early portion of our journey afforded views of great beauty, backwards from succeeding heights over Plymouth, Devonport, and the vicinity, and frequent glimpses of fine river scenery by our side. The remainder of our way, however, became somewhat tedious, although the inside company was varied and amusing. Going on rather slowly, we commenced a series of innuendoes, and at length open objurgations, against Beccy for her jaded horse, whose evident weakness was indeed bad compared with the heaviness of the load. Beccy became unruly, and abdicated in favour of her grandson, the lad who had loaded. To repel our calumnies, her grandson unfortunately applied stimulants too liberally for the exhausted constitution of the horse.

There is a long downhill descent to the romantic village of Essingbury, and this presented too great a temptation to our young Phaeton to be resisted. He cracked his stump whip, and lashed the unlucky brute, until even that patient animal showed signs of rebellion. But as the driver was about to add insult to injury, in spite of my vociferations, in the deepest part of his descent I lifted myself to seize the reins; in vain, however, for I found the lad had a stubborn spirit, probably increased by a glass or two of beer, which I had paid for—and he cracked lash upon lash, till the old horse was urged into a jumbling canter of such uneasy motion as to shake the van and all the passengers most perilously. Still the driver seemed more eager to lash, and was almost infuriated if checked.

I had just ascertained my relative position to the carboy of vitriol, when—in one instant—the crazy old van jerked up, and lo! an immediate CRASH! Off went Beccy (who completed one

entire revolution in her course), the driver grandson, myself, and the excise-officer!

As soon as we scrambled up, we found ourselves but little hurt, and then we looked into the vehicle itself. The back wheel only had been broken. Had it been a front wheel the consequences would have been very serious. The females were in a dreadful state of alarm, and the children screaming shrilly enough. The tall man, whose head without his hat touched the roof, was altered in position, and highly inclined in his direction out of the perpendicular. The excise-officer's friend, who had lately straddled over the two casks, had now one on the top of him; and my own friend was thrown upon a stout female, who herself was cast upon the top of the carboy! This female afterwards turned out to be our landlady at the inn at Looe. In the van, at this time, she was any thing but civil as landladies are.

To detail the difficulties we encountered in obtaining reluctant assistance at Essingbury, and in refitting our vehicle, would be uninteresting to all but ourselves. Suffice it to say, that the grandson, now sobered and penitent, got the whole done; replaced sundry fallen packages, and begged us to walk as far on as we could, which we willingly did. Just as he came up with us again, we heard Beccy inside the van, explaining to a stranger how she lost the three pounds of butter at Torpoint—with all the freshness of the butter itself, and of a new story.

Again we got in, and in a short time arrived at the Salutation Inn, at East Looe, at the late hour of eleven o'clock at night. The landlady forgave my friend his weighty compliment and the crushing of a small basket, and prepared us tea, toast, and comfortable apartments. Before we retired for the night, I went down-stairs to ask for something, and there I heard once more, and for the last time, our old friend Beccy within the bar, recounting the catastrophe, not of our upset, by which she lost nothing, but of the *three pounds of fresh butter*, which I firmly believe she may be heard recounting somewhere to this day! She had spoken at least sixteen times of it during the sixteen miles we had travelled.

THE TOWN OF LOOE.

A fashionable person would not have been delighted with Looe or the Salutation Inn by daylight—but we had our gratifications in both. East and West Looe are situated on the east and west sides of the river Looe, at 234 miles from London by Plymouth. We almost regretted that the golden flood of morning had so far dispelled the romance of the night; for the reality was very far inferior to our anticipation, formed on the previous night, when in Beccy's van we descended into a valley studded on each side with numerous glimmering lights, which gradually increased in number and brightness as they approached the bottom. Then the dull boom of the neighbouring sea, and the partial illumination of the moon revealing portions of overhanging hills, all conspired to render the scene by moonlight promising and attractive.

A walk by daylight displayed a few very narrow streets, situated on both sides of the river, and connected by an old and curious stone bridge below the towns. This bridge is no less than 384 (some say 423) feet in length, but only six feet two inches wide. It consists of fourteen arches, of fourteen sizes—for the object seems to have been to vary them. The piers, or buttresses of the arches, project at the summit, and are wrought into receptacles of rest for passengers—like those on Waterloo Bridge in London; or, perhaps, to permit people to squeeze into them when vehicles meet in the roadway, as it is only just wide enough for one at a time. It is said to have been a bridge as long since as the commencement of the fifteenth century, and Looe is said to have been a town in the time of Edward I. Perhaps only the foundations of town and bridge now remain. From this bridge, in the morning, we both thought we had never beheld a prettier and more primitive place. You see the towns on either hand rising sparsely up the hills, which in some portions are thickly and beautifully wooded. Above the houses, and between them, you see gardens sloping on the hills, and

separated by stone terraces; so that they seem to be, in miniature and in rough, like the hanging gardens of Eastern cities. In these gardens, when you enter them, you find the fuchsia flourishing strongly and showily, and that tender plant with us, the hydrangea, a frequent open air resident.

In truth, the climate is remarkably mild here, and in many other parts on the sea-coast of Cornwall. Penzance is noted for its genial air; and in a valley near that town, you may find the myrtle and other plants growing close to the seashore.

When you enter and examine the two little towns, you can count the houses, and you find that East Looe has 142 houses and 770 inhabitants, and West Looe 100 houses and some 600 or 700 inhabitants. Each of these places formerly sent two members to parliament. The houses of the towns run straggling out towards the sea, forming narrow little necks of streets, and leading every now and then to primitive quays projecting over the waters. The number of turnings and windings, and hiding-places and angles, in the course of the 142 houses of East Looe, is astonishing. The oldest houses are placed and approached in the most varied and irregular modes; now down steps, now up steps, now by doors in the front, then by doors in the back, and again by doors in the sides, and lastly, by doors from the water. The contrivances strongly smack of smuggling in former days. Wo to the unlucky revenue-officer who was lost amongst these traps at night, without a lamp, or light, or friend! It seems difficult to credit the boast of the town of East Looe, that it was once the mother port of Plymouth.

The summits of the hills in the vicinity, present marine, river, and land views of uncommon beauty; and the walks on the sides of the river for two miles, to Trelawney Mill, and thence in the neighbourhood of Trelawney House and Vale, comprise scenery not excelled in Cornwall, and seldom out of it. In visiting these scenes we spent a long summer's day, and would advise every traveller to do the same; there are few spots in England where he will find so great a variety, and so quick a succession of scenic views. Indeed, my professional companion, who often has the mania upon him of retiring to economize, had

serious thoughts of pitching his tent at Looe, and found upon inquiry that he could live there "like a captain" for about £100 per annum, taking a venture or two in the pilchard fisheries by way of excitement. Our landlady hinted to him, that if he chose to start a good van from and to Torpoint, she thought he might drive Beccy off the road, and make a good penny of it! He need not drive it himself, but keep an eye over it! But the thing that nearly settled my friend at Looe, was a nice neat little cottage at the top of the hill, with a beautiful little garden—rent £9 per annum. However, I got him away from Looe, and that by another van which went to Fowey, nine miles further on; but, before we leave Looe, I think it the very place in which to speak of what we first witnessed there, namely, the pilchard fishery of Cornwall. We gathered larger information elsewhere, but I may as well collect it all into this place; for, although we go into Cornwall to see mines and miners, I believe, if you ask the sea-coast people what Cornwall is most famous for, they would in a moment answer—pilchards.

THE PILCHARD FISHERY OF CORNWALL.

Pilchards are to Cornwall what herrings are to Yarmouth, cotton to Manchester, pigs to Ireland, and coals to Newcastle. In fact, it is doubtful if the Cornish people would not perish by inches if pilchards became extinct. If any one wants to know what pilchards are to a town, let him visit St. Ives. Seldom have I enjoyed a sea view more, than when descending the hill that overlooks the town of St. Ives, which town looks beautiful from the said hill, situated as it is on a finely curved bay, whose sands are very white. But he who wishes to think well of St. Ives should depart without entering it; when fairly (or partly) in it, you find it to be a small, old, narrow, unpaved (or only paved with flats) hole of a town. From one side to the other of it, in every corner, cottage, lane, loft, room, inn, chapel, and church thereof, there is but one odour, and that is the reeking odour of pilchards! We retreated into Stephens' hotel as the most

promising; but, alas! the pilchards followed us with their perpetual and penetrating odour. We ordered roast beef, but fancied we dined off pilchards; we ordered brandy and water, but the pilchards had polluted the brandy; we went to bed at nine to avoid the pilchards, but they seemed to be under and over the bed, in the walls, in the bed-curtains, in the cupboards, and in the pillows! I thought of a tenderly beloved individual in order to forget the pilchards; but, somehow or other, she suddenly became a mermaid, the lower half of her person being the lower half of an enormous pilchard! I tried to get out to her (in imagination), and, hearing the booming of the ocean in the bay, I descended; but no sooner had I launched than I found my boat surrounded with a shoal of pilchards, some of whom leaped over the gunwale, and others into my lap, and I believe I should have gone mad under the gathering, leaping, and loading of pilchards, if the "boots" had not just then knocked at my door, saying, "Seven o'clock, sir, if you please!"

I jumped up, thinking I had got away from pilchards now, and dressed, and ran down to the beach for fresh air—More pilchards! But at last I found other fish, and diverted my attention by gazing on some of the most extraordinary conger-eels I ever beheld. They were lying in rows on the sands, and had been caught by hook and line. Some single congers weighed from twenty-five to thirty pounds. They are delicious fishes if well cooked, but bony; yet they only fetched about a penny a pound retail, chiefly on account of the prejudice of the people against them. This prejudice arises from their likeness to large serpents, and the people say they don't like "sarpant-meat!"

Having scented and dreamt so much of pilchards, it is time I should notice the fishery as a fact. To show their abundance when the shoals came upon the coast, I may mention that at this very town of St. Ives, upon one occasion, no less than 1000 hogsheads of these fishes were taken in the first three seine nets cast into the sea.

At a small fishing cove named Trereen, about 600 hogsheads were taken in little more than one week of August 1850. It is supposed that about 2400 fish make a hogshead, and thence

you see that no less than 1,440,000 pilchards were caught by the fishermen of one small village on the coast at the beginning of the season! It may be estimated that the number of hogsheads exported annually, averages 22,000! No less than 27,000 hogsheads were secured for foreign markets in the year 1850. Thence it will be at once seen that the pilchard fishery is a very important business.

Pilchards are not unlike herrings, but rather smaller in size, and larger in scales. Their origin is totally uncertain; whence they come and go, no one can tell. It is one among a thousand proofs of the goodness of the Great Benefactor, that as early as July these little creatures, whose return is looked for with far more eagerness than that of the summer itself, are met with swimming past the Scilly Isles, when they can be caught with a drift-net. During the month of August they advance inland, when the principal or in-shore fishing begins. The shoals visit different parts of the coast until October or November, after which they disappear until the next year. Though sometimes caught off the south-west part of Devonshire, and occasionally met with near the southernmost coast of Ireland; yet beyond these two points they are never seen in any other portion of the British shore, either before they approach or after they gain the Cornish coast. They completely elude the naturalist. The shipping or boating connected with this fishing is as follows:—The principal boat is about fifteen tons in burthen, and in it is placed a large net called locally the "seine;" the origin of which term is, I believe, French. The net measures 190 fathoms in length, and costs about £170, or more. It is one long strip of netting, from eleven to thirteen fathoms in breadth, composed of very small meshes, and furnished throughout its length with lead at one side, and corks at the other. The men who cast this net are termed the "shooters," and they gain for this work 11*s.* 6*d.* a week, and a perquisite of one basket of fish out of every haul they make.

On the Hill of Looe we observed what I had best relate here. We saw a man walking steadily along a narrow path, on the highest ground overlooking the sea. He had a peculiar abstract-

ed look, and turned away from us, and often fixed his eye upon the sea, shading his brow with his hand. Then he would seem disappointed, and turn round and gaze harshly at us. We walked on. Once more he came back, and scrutinized the far-spreading deep. "Ah!" said my friend, who was a feeling man and a father, "that man has sent a son to sea—I see how it is. You observe that boat yonder, that large boat; that very boat, I doubt not, conveys his son—perhaps to embark for Australia—perhaps for New Zealand. Well! the short and simple annals of the poor, are as full of feeling and sorrow at parting, as the annals of people like ourselves. Who can conceive what weepings and wailings were seen and heard last night, in some one of those queer cottages below! A mother's heart was half-broken, sisters were shedding hot tears, brothers dropped one or two manly tears, or boyish tears; and that father there—you see the man cannot weep! his grief is too deep for tears—yet he seems to brush his brow occasionally. Don't interrupt the poor fisherman's grief—it is sacred. Under that rough exterior there beats, I doubt not, as warm and tender a heart as under the most polished exterior. How eagerly does the man stare into that boat! He appears to fix his eye on the son in it. Look at the man, he is making a sign—he is waving his great shawl handkerchief; look at the boat, there is the son answering him by signs! Ah! I should like to know the history of that father and son."

I was not held back by the same reverence as my friend for private sorrow, and therefore I went up to the man, the father, who indeed was so absorbed in his grief, that he scarcely heeded my approach. I stood by him as he strained his eye, and shaded his brow, and watched the boat, as if he would fly to it, or follow it, or perish in the attempt. I soon felt a little awe of him; for he was a big fellow, and seemed very doubtful and uncertain in his moodiness. But I would have the history of the son and the parting for my note-book; so, as soon as he turned his eye off the sea, and met mine, I ventured to address him:—"Excuse me, my good man, excuse my intrusion upon your private sorrows; but both I and my friend there, deeply sympathize

with your evident grief. We conjecture that you have a son in that boat, going abroad. Will you tell us to where?"—The big man looked at me with a peculiar mazed glance. Again I repeated the latter part of my question; when at length he broke silence, and roughly exclaimed, "I don't know what you mean, sir." "Well," said I, "we know we have no right to intrude upon your private and paternal feelings; but that is your son you are gazing at so earnestly on the sea, is it not?" "My son, sir? I don't know what you mean, sir," answered the man again. "Who or what, then, are you looking for, so fixedly on the ocean?" "Looking for, sir? why, for *pilchards!*" "For what?" cried my friend, who did not catch the answer; "for *pilchards!*" repeated I—"for *pilchards!*" Whereupon our hearty laughter amazed the man as much as my previous questions.

This big man was a *huer*. Every fishing town and village commissions one or more huers on the heights above sea, when the pilchards are expected to come in. Such men are termed huers from the old French word *huer*, to give an alarm; and hence perhaps the word *hue*, in "hue and cry." The huer stands where he can command an uninterrupted view of the sea, some days before the pilchards are expected to appear; and at the same time, boats, nets, and men are all ready. The first thing which the huer looks for is a discolouring of the sea, described to me as if it were a leaden cloud just under the surface. This discolouring then comes inland, shifting and changing its hue and limits; for it is caused by the presence of the shoal of pilchards. Soon the pilchards can be seen leaping and playing on the surface in increasing numbers, and they will perhaps approach the shore so closely that they can be caught in shallow water; seldom in more than fifty or sixty feet water. In instances of great shoals, the fish on the outside have forced the fish inside up to the very beach, so that they could be caught in buckets. This impulse to approach the land periodically, is one of the most curious facts in their natural history: whether it arise from any necessity to get food, or not, can scarcely be determined.

The huer on Looe cliff was employed in this very look-out when we saw him. As soon as such a man discerns the coming

and clouding shoal, he waves a handkerchief or branch of a tree, and men and boys near him convey the same signal to the beach. The seine boat and another small boat have been rowed out to act under his directions. All eyes are fixed on the huer, who stands solemn and watchful—shading his brow with one hand, and waving his signal branch with the other. The shoal of fish begin to press on, thousands upon thousands; the dark leaden cloud becomes a silvery, scaly, glancing cloud. When the shoal is fully within the shallow water, which the local huer knows full well, and when the fish begin to settle and to crowd closer and closer, then the huer gives the last decisive wave. Before, he had waved left or right, as the shoal shifted, that the seine boat might follow it—now he waves straight down, and thereon the seine net is shot overboard as speedily as possible. The leads sink the seine net at one end vertically towards the ground, while the floats buoy up the other end on the surface. When it has been carried all round the fish, the two extremities are made fast, and the shoal is then imprisoned within an oblong barrier of net-work; much practical skill being required in preventing more than a few of the pilchards from escaping. The huer has a great advantage upon his watch-tower of cliff or hill; for he can discern any attempts by the pilchards to escape, in the shifting or separation of a part of the cloud upon the waters. To this he instantly directs attention, and the boatmen row out to the fugitives with rapidity and skill, and manage to include them in the net. When the seine is full, it may be allowed to remain in the sea for some days, being secured against removal by storm, with ropes extending to prominent points of land, and being also contracted by the union of its opposite ends, which are strongly fastened.

There is a smaller net called the "tuck" net, which is now employed and arranged by men who receive ten shillings per week, and who let it down inside the large seine net, in order to bring the fish closely collected to the surface. They row their boat inside the seine net, and lap it close to the seine boat, which remains outside and stationary. The "tuck" boat then makes the inner circuit of the "seine," the smaller net being dropped

overboard as she goes, and at intervals attached to the larger. The fish are drawn into the middle of the enclosure by beating the water with oars and loaded ropes. When the tuck net has at last been brought round the whole range of the seine, and securely fastened to the seine boat at the end, they commence the hauling of the fish to the surface, which is a great event, and anxiously watched.

Now the scene on shore and sea rises to a prodigious pitch of excitement. The merchants to whom the boats and nets belong, and by whom the men are employed, join the "huer" on the cliff; all their friends follow them; boys shout, dogs bark madly; every little boat in the place pulls off crammed with idle spectators; old men and women hobble down to the beach to await the news. The noise, the bustle, and the agitation increase every moment. Soon the shrill cheering of the boys is joined by the deep cries of the "seiners."

There they stand, six or eight stalwart, sunburnt fellows, ranged in a row in the "seine" boat, hauling with all their might at the tuck net, and roaring the regular nautical "Yo—heave—ho" in chorus. Higher and higher rises the net, louder and louder shout the boys and the idlers. The merchant forgets his dignity, and joins them; the huer, so calm and collected hitherto, loses his self-possession, and waves his cap triumphantly. Even you and I, reader, uninitiated spectators though we are, catch the infection, and cheer away with the rest, as if our bread depended on the effect of the next few minutes. "Hooray! hooray—Yo hoy—hoy—hoy! Pull away, boys! Here she comes! Here they are! here they are!" The water boils and eddies; the tuck net rises to the surface, one teeming, convulsed mass of shining, glancing, silvery scales; and one compact crowd of thousands of fish, each one of which is madly endeavouring to escape, appears in an instant.

"The noise before was as nothing compared with this noise now. Boats as large as barges are pulled up in hot haste all round the net; baskets are forwarded by dozens; the fish are dipped up in them and shot out, like coals out of a sack, into the boats. Erelong the men are up to their ankles in pilchards; they jump upon

the rowing benches and work on, until the boats are filled with fish as full as they can hold, and the gunwales are within two or three inches of the water. Even yet the haul is not exhausted; the tuck net must be again let down, and left ready for a last haul, while the boats are strongly propelled to the shore, where we must join them without delay.

"As soon as the fish are brought to land, one set of men, having capacious wooden shovels, spring in among them; and another set bring large hand-barrows close to the side of the boat, into which the pilchards are thrown with amazing rapidity. This operation proceeds without ceasing for a moment. As soon as one barrow is ready to be carried to the salting-house, another is waiting to be filled. When this labour is performed by night, which is often the case, the scene becomes doubly picturesque. The men with the shovels standing up to their knees in pilchards, working energetically; the crowd stretching down from the salting-house, across the beach, and hemming in the boat all around; the uninterrupted process of men hurrying backwards and forwards with their barrows, through a narrow way, kept clear for them in the throng; the glare of the lanterns giving light to the workmen, and throwing red flashes on the fish as they fly incessantly from the shovel over the side of the boat;—all together combine such a series of striking contrasts, such a moving picture of bustle and animation, as not even the most careless of spectators could ever forget."*

The business of the salting-house is quite a methodical affair. Having followed the wise advice of "first catch your fish," the owners arrange well for their preservation. In a large stone building you may see women and girls piling up the pilchards on layers of salt, for threepence an hour, and a glass of brandy. The fish are wheeled in upon barrows, trains of which are constantly going in and coming out. Furtive propensities and pri-

* Collins' Rambles beyond Railways, 8vo, 1852, where the whole process of catching and preserving pilchards is described. There is a useful tract on the pilchard and pilchard fishery, by Jonathan Couch, Esq., in the third Annual Report of the Royal Cornwall Polytechnic Society (Falmouth). Several paragraphs in the newspapers have recorded the past season as favourable.

vileges are repressed by a boy, who is armed with a cane, which he flourishes with a rapidity and a tyranny strongly reminding us of our old schoolmaster. Inside the salting-house, companies of chattering and screaming females are building up pilchards to heights of four and five feet. Though working separately, they work methodically, and finally the heap seems like a "long, solid, neatly made mass of dirty salt; nothing being now seen of the pilchards but the extreme tips of their noses or tails, just peeping out in rows up the side of the pile."

The fish remain in salt, in the main bulk, for five or six weeks, during which a quantity of oil, salt, and water, drips from them into wells cut in the centre of the stone floor on which they are placed. The oil, when collected and clarified, will sell for enough to pay the whole expense of the wages, food, and drink, given to the "seiners." The remnants furnish a valuable manure; and a Cornish pilchard-fisherman will boast with glee, that nothing in the pilchard itself, or in its curing, runs to waste. Every part of the little fish, and every part of the curative process, is remunerative. When, finally, they are taken out of bulk, they are washed clean in salt water, and packed in hogsheads, which are exported to the shores of the Mediterranean. Italy and Spain are the two great foreign markets for pilchards, the home consumption being insignificant. The average wholesale price, in the export trade, is about fifty shillings per hogshead. The markets in Italy and Spain are always open to any amount of supply, the fish being there considered a great delicacy. Strange that the shoals should come, from an unknown distance, to the Cornish coast; should be caught and cured there, and sent away again to a foreign coast; that they should be esteemed a greater delicacy abroad than at home; and that a whole mass of Methodist heretics (as Papists would say), on the English coast, should live by preparing food for feasts and fasts of a mass of bigoted Papists! Ah! Father Ignatius little knows what he would lose if his favourite schemes for the "conversion of England" were realized—the choice lies between pilchards and popery! For there can be no doubt that, in case of our conversion to popery, all the pilchards would be consumed

at home, on Fridays and fast-days; then the orthodox Italians and Spaniards would positively be compelled to find other fish, or starve, just because those heretics in England had at last been converted! Then the very "seal of the fisherman" wouldn't bring pilchards for Spaniards!

TO FOWEY: FOWEY AND HARBOUR.

We have caught our shoal of pilchards at Looe, and having salted them and supplied the Papists, it is high time we should start from Looe for Fowey—which is nine miles further, and Fowey is as famous for salmon as Looe and St. Ives for pilchards. Another van offers, and in it we ride; about midway is Pelynt, a hamlet containing a neat church, in which is a curious old monumental tablet for "Edward Trelawnye, 1630," containing this inscription in olden character:—

> "O what a bubble, vapour, puffe of breath,
> A nest of worms, a lump of pallid earth,
> Is mud-wald man! before we mount on high
> To cope with change, *we wander, alter, dy.*" (die.)

The last four words form an anagram of the name Edward Trelawnye. Then follows a Latin couplet with an English version of it, thus:—

> "Causidicum claudit tumulus, miraris, honestum,
> Gentibus hoc cunctis dixeris esse novum."

> "Here lyes an honest Lawyer, wot you what
> A thing for all the world to wonder at."

We should have scanned all the monuments, but could not persuade the driver of our van to halt any longer for sixpence. This driver was old Beccy's grandson, a one-eyed and red-haired young man, who had freighted his van quite as heavily as Beccy's had been freighted for Torpoint.

Our company consisted of tradespeople belonging mostly to Fowey. According to their testimony, Fowey was one of the worst places for its size in Cornwall. But, upon farther inquiry, we found that this character was given to the place by the

travellers chiefly with reference to their respective trades;—by a lean, sour-looking man, because, as he confessed, Fowey needed very few *shoes* of all sizes, for all ages, and at all prices;—by a snub-nosed, middle-aged man, who reposed on a hamper at the top of the van, because the Foweyites would persist in wearing four-and-sixpenny *hats*, and too few of them;—and by a spruce, dapper youth, who occupied one of the outside seats, because his orders for *cloth* and woollen-drapery had not increased in proportion to his own acquaintance with the town and townsmen. Upon venturing to inquire of one who, from his nautical style, appeared to be at least capable of expatiating on the well-known harbour of Fowey, we were equally baffled; for the sailor had not seen the harbour for the last eight years, having been absent in Canada. We were then examined as to our own object in visiting Fowey, the shoemaker, the hatter, and the draper, all feeling anxious to know if we were rivals in trade in disguise. Scarcely could we persuade the tradesmen that we were simply on a tour of pleasure. They regarded us with doubtful looks; and when we declared that we were going to the Land's End for the same object, a sneer of contemptuous doubt was observable on the countenances of most—the sailor excepted. In vain we protested that we dealt neither in "soft goods" nor hardware, nor in any thing. After this we could elicit no more remarks from any one; and even Beccy's grandson looked queerly out of his one eye, and we found ourselves regarded with distrust and suspicion—the hatter looking sharply for hats, the shoemaker for shoes, and the dapper draper for a bundle and a yard measure.

As we approached Fowey, the sailor began to warm with anticipation of friendly greetings and recognition. The landlord of the next inn was eagerly interrogated as to his remembrance of Harry Penelly. The said landlord mused, and then began to recollect something of Harry, and was about to draw a jug of cider for him, when his old mother (the landlord's) squeaked a few sentences about "a many impostors and deceivers in the latter days," instancing a case by name, which had the effect of restoring the jug to its shelf, and of evidently re-

freshing mine host's memory in the wrong direction. However, the tide soon began to turn in Harry's favour, and a fair wind set in; for, long before we reached Fowey harbour, recognitions and blessings began to pour in upon Harry Penelly with such force, that he had much difficulty to carry sail, and the van itself was in no small danger of being capsized by Harry's friends crowding aboard. Soon after descending a hill more like the face of a cliff than a road, we reached Bodinnick Ferry, which crosses Fowey Harbour, one of the most safe and beautiful in her Majesty's dominions. Harry could scarcely rest in the ferry-boat without dancing a hornpipe—and there was some risk of his being ignobly wrecked in a ferry-barge, after all his adventures and escapes in Canada.

Fowey is a lamentably wasted town (240 miles from London, and 243½ the way we have come), stretching for nearly a mile along the bank of the river of the same name, and having streets full of angles, and heaps of rubbish at each angle. The inn was old, so was the landlady, so was the waiter, so was the scale of charges, and so was *not* the wine:—it was the only thing that smacked of novelty. The termination of the town and of a rope-walk brought me to the sides of the cliffs, which embrace the harbour; and beautiful cliffs they were, especially on the very sea-shore, abounding in rocky caves and promontories of pleasing and striking effect. The ruins of two square stone forts or block-houses, are seen fronting the narrow entrance from the harbour to the sea, one on each side, built in the reign of Edward IV., provided with port-holes, and having walls six feet thick; and it is said that a chain drawn across from tower to tower once defended the harbour—in proof of which you may see a couple of links of this chain at Menabilly, a neighbouring seat.

The chief ornament of Fowey is a beautiful mansion, called "Place House"—built by, and belonging to, Mr. Treffry. That enterprising gentleman died about three years ago. It was not completed; but was designed as an elegant castellated building, the interior being filled with oak carving and wainscoting quite in character. One room is lined with oak, once composing the ship Bellerophon, which carried Napoleon Buonaparte. The

drawing-room is magnificently roofed, and panelled with slabs of polished porphyry, granite, and marble. Some parts of the passages are paved with polished porphyry and granite, and from the windows you catch fine views of the grounds and the harbour. A machine was erected at Fowey Consols to polish some of the stones. The wealthy proprietor was also the chief proprietor of Fowey Consols mines, of which I shall speak presently.

Most matter-of-fact travellers leave Lostwithiel unvisited, though very foolishly. We determined to see all that could be seen, and therefore to go there. But to reach Lostwithiel, it was necessary to make the acquaintance of Tom Trestrick, an old weatherbeaten, good-humoured son of the Oar and the Sail. While rowing us down the stream he recited his *souvenirs* of war and wine, of Italy and America, and, by way of interjection, of the late and present possessors of the gentlemen's seats on the river side. The scenery on the banks and cliffs overhanging the river, is changeful and charming, and about the most beautiful in the county. The banks and slopes were commonly well wooded for the whole six miles of the river's course. On the eastern bank, about half-way, is situated St. Winnow's church, upon the very bank of the river, embosomed in close covering woods. This projection commands glorious reaches of river scenery, including all that can delight the eye and calm the fevered mind. Soon after this little church was passed, the river began to narrow more and more, and at length Tom Trestrick landed us below the little town of Lostwithiel, said to be the ancient Uxella of Ptolemy, and, according to Tom Trestrick, named as at present from Lost-with-all. The little town is pleasantly situated, and possesses an elevated and highly ornamented church tower, with an octagonal lantern and spire of decorated English, which was visible far down the river.

A walk of a couple of miles beyond the town brought us to the ruins of Restormel castle, far more picturesque than many better known. The ruin consists of a double circle of ivy-mantled walls and towers, placed on a commanding eminence—the base of which is watered by the river Fowey. A brier-filled moat, overgrown mounds, and rank vegetation, all over-

arched by beautiful trees, defend and conceal the ruins of nine feet walls, and masses of fallen or falling masonry—which must at one time have been impregnable to all attacks. The keep now alone remains, on a steep mound formed out of a rocky hill, and leaving a deep ditch. The part enclosed is a circular area of 110 feet diameter: it has walls ten feet thick at the top. The south side has a drawbridge, and an entrance under an outer and inner arch, partly remaining. The remains of three regular suites of apartments may be distinctly traced around the circular area. This castle was once the residence of the Earls of Cornwall. In the earlier periods it must have been a gem of a little castle, and I sat an hour or more on the battlements (about thirty-five feet from the floor of the ground rooms), musing on its former inhabitants, and the time of Edward III., Henry V., and even of the first Charles, when Fowey was in all its glory of town and harbour. Seldom do you get finer river reaches and wooded views in combination, than from the top of the ruins of Restormel castle.

Our worthy rower, Tom Trestrick, desired to row us back, but we awaited the conveyance to St. Austell. It was very much loaded, and what with walking up-hill to save the horse, and down-hill to save our necks, we travelled pretty nearly two-thirds of the journey (eight miles) on our proper feet:—which journey, with the exception of abundant mines, and engine chimneys, and abundant children of all ages, the peculiar property of the miners, afforded little interest to us. We passed St. Blazey, a village surrounded with new mines, and the birthplace of Bishop Blazes, the patron of the wool-combing trade.

ST. AUSTELL, AND THE EASTERN MINING DISTRICT.

We arrived at this town on the evening of market-day—a melancholy time for any small town (St. Austell was no exception), and any intruding visiters. The Cornish men rank this town as being about the fourth or fifth best for business; but to us it was only a town having narrow streets, ill-paved, and a fine old church tower, curiously ornamented

with figures half-way up, and overtopping a church dedicated to St. Austell, an Irish saint.

We repaired to our inn *after* the market-day farmers had left it, and unprotected, as those gentlemen call themselves, wo to the unlucky travellers who visit an inn where they have gathered strongly! Locust-like, they had devoured the edibles, and left us remains which were neither tender nor tempting. Nothing appeared to inspirit us, and our only resource was to gaze upon a fine show opposite the inn parlour, where we saw portrayed on figured canvass, wondrous giants, dwarfs, flaxen-haired ladies, and prodigiously fat boys;—with a learned pig and a fearful alligator thrown in by way of variety.

The great and rich mines of Polgooth once contributed to the rise of St. Austell, as the copper mines of Crennis and other mines around now do. In the vicinity are several stream tin works, the principal being "Happy Union," in Pentuan Vale. This valley is a termination of St. Austell moor, where for ages a great quantity of tin has been obtained by streaming. In some parts it is 600 feet in breadth, and in others not more than 300.

The tin ground lies on the solid rock, and is generally from three to six, and sometimes ten feet in thickness. The quantity of tin ground opened at Pentuan had been 18,200 square fathoms, and the average of black-tin got per square fathom has been 186 pounds. The quantity of "overburthen," or waste, removed, has been upwards of 200,000 tons.

Happy Union was first opened in 1780—Wheal Virgin forming a part of it; the former being worked towards the sea, and the latter towards St. Austell moor. About this vicinity also are the *Merry Meeting* stream works, the *Rock*, near St. Austell, the *Grove*, the *Water-Gate*, &c. I shall speak more particularly of stream tin-works under the head of tin and tin mining.

The St. Austell mining district is principally stanniferous (producing tin); the upper lodes being chiefly confined to its south-eastern side, anciently the very productive and extensive mine of Fowey Consols, and the Crennis lodes, from which much valuable copper ore has been extracted.

If we extend our view to the entire "Eastern District," so as to include the mines of Callington, Liskeard, and Tavistock, then we may observe that the neighbourhood of Callington is both stanniferous and cupriferous (producing copper), with a few silver lodes. At Wheal Duchy, near Callington, a silver lode was found, at the ten fathoms level, which was worth £200 per fathom, and from which £3000 of silver was raised.

Dartmoor is stanniferous (tin-bearing); the mines around Tavistock are cupriferous (copper-bearing). On the north are the lead lodes of Wheal Betsy and Lidford, and on the south the argentiferous lead mines of Beer Alston. In 1812, silver was raised from Wheal Brothers to the amount of £3000. Iron, as a brown hæmatite of excellent quality, has been found near Lostwithiel and Bodmin, and "cross courses," holding iron ore, occur in a north and south direction at Nantallan Downs and Laniret Downs, near Bodmin. Between 1778 and 1802, 9293 tons of iron ore were shipped from the lode near Combe Martin to Llannelly, South Wales. The lodes in this district generally run east and west, partly traversed by a powerful cross course—which heaves the lodes to the right.

Several fine lodes of rich hæmatite iron ore are found in this district, and have been worked at various times. A great many mines have been working of recent years in the neighbourhood of South Caradon. The principal mines in the St. Austell district are known by the familiar names (to miners) of Fowey Consols, Par Consols, Charleston United Mines, Old Crennis copper mine, Polgooth, South Caradon, Cornwall Great United Mines (in which from £70 to £80,000 have been expended), Wheal Friendship tin and copper mine, Combe Martin Mines (which made great returns of silver from the time of Edward I. and Edward II., were reopened in time of Elizabeth, and in the Commonwealth recommended to the notice of Government); Wheal Franco copper mine, near Tavistock (which commenced in 1823, and returned about £60,000 worth of ore, but afterwards did not pay expenses); Gunnis Lake Mine, on the bank of the Tamar (celebrated for its rare and beautiful varieties of copper ore, worked by several

companies, and has yielded more than £250,000 worth of ore); Drake Walls tin mines (very ancient and productive); and Tamar silver lead mines in Beeralston, Devon (the lead of which is very rich in silver, yielding in average 60 to 65 ounces of silver per ton of lead).

Such is a hasty glance at the chief mines in the eastern district of Cornwall and Devon—the fortunes and features of which are frequently varying.

CARCLAZE TIN MINE.

This remarkable and ancient mine is situated near the town of St. Austell, and consists of a large open excavation of a mile in circuit, from 20 to 30 fathoms in depth. Its exact dimensions are said to be 250 fathoms in length, 100 fathoms in breadth, and 22 fathoms in depth. Some years since, Mr. Thomas measured this remarkable mine himself, and found the excavation occupied five acres statute, its depth being 136 feet. The solid content was 63,000 cubic fathoms, and about one million tons had been removed. The elevation of the northern side was 685 feet above high water; of the southern, 670 feet.

During the period that mining operations were conducted with activity here, a stamping mill, worked by steam, was erected at the very bottom of the excavation. This still remains, though it has long been unused. Several water-wheels, worked by streams from the neighbouring commons, now propel the machinery for crushing the stones, loosened by the water as it flows down the sides of the cavity. Within memory the water was navigable, and the ores were removed in a boat.

This mine is wrought in a dreary, and barren hilly common, which you might traverse for hours without suspecting the vicinity of a mine. The situation is not marked by engine-house and chimney towering aloft, as in other mines; and the whole business is confined to the interior of the punch-bowl hollow. You see the whole at once, and in these particulars you will not find any other mine like it. No shafts of any depth

are sunk below its base; and it would seem as if a complete mine had been turned inside out, for the benefit of timid travellers, who would wish to see the work of mining without the risk and fatigue of a descent below the surface. The ore is obtained without much difficulty, and it is separated from the stone by repeated washings in little streams conducted to, and moving various water-wheels arranged in the bottom, and along the sides of the excavation. There must be an almost exhaustless store of the tin ore in this mine; for the miners say it has been worked for 400 years, and it is constantly increasing in its superficial works and extent. It is indeed a remarkable object when viewed in the whole, taking in its white cliff sides of pointed abruptness, its self-contained completeness, its ever-widening extent, and the suddenness with which the whole is presented in one view to the stranger, with its men, women, and children scattered over the works. The ground which is laid open here, is almost wholly composed of soft growan (decomposed granite), through which runs a numerous assemblage of schorl and quartz lodes in the usual direction. These, as they contain tin, are the sole objects of mining adventure, and the removal of the soft growan is effected by a stream of water, which conveys all the refuse of the mine through the adit. I believe there is no instance of a mine so worked, or of a mine the working of which is attended with so little labour.

In respect to the lodes or veins which are so numerous here, this mine would be called a *stockwork* by the Germans; but, as far as regards the soft growan which contains these veins, it may not improperly be called a clay pit.

MARAZION AND ST. MICHAEL'S MOUNT: SCENERY AND HISTORY.

I pass over some of the principal towns and all intermediate scenes without notice, because accounts of them are readily found in books, and I do not pause until I arrive with my friend at the town of Marazion, or Market Jew, situated on the coast of the beautiful Mount's Bay, 281 miles from London (through Exeter, Launceston, Bodmin, &c.), and fifteen miles from the Land's End.

This town is built on the steps of a hill rising towards the north, and which shelters it from cold winds. The consequent mildness of temperature renders the town inviting to invalids.

The origin of the popular name of Market Jew has been much disputed; some suppose that the town had at an early period a market, to which foreign Jews came to buy tin. It is, however, chiefly known in association with St. Michael's Mount, which is connected with the mainland by the sands when the tide is out, but is insulated when it is high water. Across the sands is a narrow causeway of pebbles, to render the communication more perfect. There is a tradition that the Mount was once distant five or six miles from the sea (though now surrounded by it), and enclosed with a very thick wood, and called in Cornish *Caraclowse in Cowse*, that is, the "Hoar Rock in the Wood." But an examination of the geological features of the base of the Mount shows that the tradition is groundless; the Mount having been separated from the land by some great convulsion far beyond the reach of tradition or historical record.

The island containing the Mount, and a level piece of ground at its foot, is about a mile in circumference, and comprehends seventy acres of surface. The Mount is 231 feet in height from the level of the sea to the platform of the chapel tower. The name is derived from the legend, that St. Michael first touched the top of this Mount with his feet as he descended from heaven to earth. At all events it was regarded with religious reverence as early as the fifth century, and in the dark ages was much resorted to as a place of pilgrimage. Previous to 1044, a priory of Benedictine monks had been established on the island; and in that year Edward the confessor gave to the monks the Mount, with all its appendages. Before 1085, it was annexed to the abbey of St. Michael in Normandy. After suppression and subsequent revival, it was given by King Edward IV. to the Brigitine nunnery at Sion, in Middlesex. At the dissolution, the lands belonging to this house were valued at £110, 12s. Of subsequent historical events connected with this Mount I will presently speak; but let us first take a look at the Mount itself,

and its present state and scenery. It is always considered one of the most attractive sights in Cornwall.

From the shore, you behold its lofty island of rock rising up proudly from the ocean, and the beautiful chapel sits upon its summit like a royal crown. As you approach in your boat, the island appears more jagged and precipitous, and the chapel more distinct. The island is in reality not always such, but connected with the main shore by a narrow sandy strip of ground, which is always under water at rising tide. When at the Mount, you walk round its base, and then up its side, by any track you prefer amongst loose and rough masses of rock. You see the chapel above you as you ascend, and you may imagine that "the church" is for once triumphant and pre-eminent. On gaining the summit, you find the chapel forming a part of the castle, which contains at least twelve rooms, independent of the dining hall (or, as it is called, the Chevy Chase room) and the public rooms. Some of these are fitted up in a superior style by the late proprietor, Sir John St. Aubyn, and the St. Aubyn family occasionally visit them in summer. You discover the chapel to be far the most interesting part of the interior, that it was once part of a Benedictine monastery, and that it is now well fitted up and possesses a fine organ, which is seldom played; but the effect of which in this situation must be very striking—especially if you should hear its sound mingled with that of the beating billows of the vexed sea.

Under one of the seats or stalls is the opening to a small ancient dungeon, wherein were found the uncoffined bones of a large man.

On returning to the tower of the castle, I ascended to its summit by climbing numerous narrow, winding stairs—and from the said summit I enjoyed a magnificent panorama of marine views. There was I perched upon the topmost pinnacle of the whole land, and surveying at my ease the whole coast, from the Lizard point to Penzance and Newlyn; and then looking out to sea, and contemplating its broad wavy mirror spread out beneath me in unbounded extent. I gazed and mused there until I became giddy, and what some plain folks will think a plain

proof of it—poetical. Three or four sonnets in my note-book relate to St. Michael's Mount, but fear not, reader—you shall be spared!

The historical circumstances associated with St. Michael's Mount, after the earlier events above noticed, are very interesting. In the time of Charles I., this Mount was garrisoned by the Royalists as one of their principal strongholds in the West. In this castle, it is said, Charles I. spoke his parting words to Sir Francis Basset, sheriff of Cornwall, exclaiming: "Mr. Sheriff, I now leave the county entirely at peace in your hands," then waving a farewell to his adherents, and passing slowly out of the fortress. This and other scenes on the Mount have been imaginatively portrayed by Mr. Collins, in his *Rambles beyond Railways*, a book before referred to, from which I may borrow the following:—"The tide is at the flow as the king reaches the foot of the Mount, and prepares to embark for the mainland. He pauses for a moment—see! he steps into the boat again to thank his Cornish friends for their loyalty, in few but kind words, and then gives the signal to proceed. The towers of the fortress above are crowded with spectators, anxiously watching his progress. He touches the shore at the town of Marazion, where a great concourse of armed men is assembled to meet him. There he mounts his horse, and rides forward slowly a few paces; then those men in the fortress whose eyesight is keenest, observe that he stops, wheels round, and looks once more, with a sorrowful attention, as they fancy, towards his trusty garrison and the sun-bright sea beyond. Viewing this, and remembering too the royal letter of thanks to the volunteers of the West, the Cornish wave their caps to a man, and renew their shoutings with tenfold enthusiasm. From the distance, their cheering voices sound clear and musical on the ears of the doomed monarch, as he turns again, and sets forth in earnest to leave Cornwall. Still, as long as he is in sight, the burly miners and peasants sustain their cry of "Long live the King," and still the martial music in the fortress joins them gaily. Little do these hardy adherents of a fatal cause think how soon the man whom they then delight to honour, shall die forsaken under the heads-

man's hands! Little do they now imagine that Charles' letter of thanks shall soon be all that remains of him to his faithful Cornish subjects—the one precious relic, the honoured words of the dead, which they shall hand down from generation to generation in after years; which they still copy and hang up on the walls of the Cornish churches, as an heirloom for the whole country to reverence and preserve! Fade, fast fade, fleeting picture of the prosperity of a few hours! Fade while the royal train is still in sight, and still brilliant to look upon; while the brave men in the fortress still keep their stronghold, though but a little time, in triumph! Fade, as the evening sun is already fading over St. Michael's Mount; and as the deceitful sun of prosperity shall soon fade on the fortune of Charles I.!

"Behold the Mount again!—the scene of strife and change, and the war and waste of human warriors through so many generations of men—still rising lofty and beautiful as ever from the surface of the deep. The Benedictine chapel yet crowns the summit; but of the fortress only some of the walls remain. What is left of the monastery is now changed into a summer dwelling-house by the owner of the Mount. Below, instead of the mud huts of the ancient Britons, or the few scattered cottages of the middle ages, we have quite a little town, with a fine granite-built harbour, large enough to contain merchantmen of 500 tons burden. Not less altered is the prospect along the shores of the bay—half the town of Marazion lay in ruins (the result of former insurrections) when Charles I. landed at it from the Mount: all the houses are now rebuilt. Look on, some three miles away on the beach, and above these long ranges of white walls fronting the sea; extending up the base of the hill in land; and backed by fields, plantations, gardens, and country dwelling-houses, all intermingled charmingly on the broad surface of the rising ground. This place has grown out of a few cottages built by fishermen; it is the most western town in Cornwall—Penzance.

"Hark! sounds of laughter and music, of happy voices and merry tunes intermingled, are audible from the Mount. A large pic-nic party is assembled there. All is glee and gaiety. The sun is shining brightly; it is the season of the pilchard fishery.

Multitudes of boats rise up in sight; fishermen are working hard, industry and activity are paramount, and—what we have not hitherto seen—peaceable. Merchants on the wharf are driving bargains, paying wages, talking politics, watching work-people—all at once. Business is not now transacted as amongst the ancient Britons—St. Michael's harbour is filled with vessels waiting to be laden with fish; but they want no soldiers to protect them, like the galleys of the Phœnicians. There is no bartering with goods on the one hand, and the weapon in the other. The noisiest speculators understand each other's interests, and pay and receive, offer and reject, in perfect security and ease.

"And above, on the top of the Mount, what a change appears after what has been seen there before! On a small space of flat ground, hard by what was once the monastery, the girls and young men of the pic-nic party are dancing merrily—dancing to the music of flute and fiddle, where the haggard Benedictines of bygone days muttered their Latin formularies, or welcomed the penitent toiling up to confess to them from the world below. A little lower down, where the Cornish volunteers sharpened their rude weapons to fight for King Charles, and drum and trumpet sounded from the bloody skirmish, the elders of the pic-nic party are comfortably sipping their wine, and looking quietly on the busy workmen on the quay beneath them. And in place of the procession of pilgrims, with their sad-coloured dresses and solemn order of march, what have we got now?—a company of excursionists, from a remote island district of the country, who have clubbed together to pay a holiday visit to St. Michael's Mount, and look at the pilchard fishery in the bay—a happy set of home-tourists of all ages, from the child, who is running himself out of breath up the steep path to the ancient chapel, to the heavy old gentleman, who picks his steps with slow discretion, pokes loose stones out of his way with his stick, and talks laboriously about Cornish antiquities to every body around him, whether they will hear him or not."

The earlier antiquities relating to St. Michael's Mount, are associated with the earliest notices of the tin trade amongst the

ancient Britons. I shall speak presently, more particularly of the early tin trade, and will only here mention that antiquaries seem to identify this Mount with the ancient *Iktis*, named by Diodorus Siculus, the ancient historian, who flourished in the time of Augustus Cæsar, and, though not myself much of an antiquary, I quite agree with them; for the reader will see from the extract from Diodorus, which I give under "Tin and Tin Mining," that the historian describes this Mount—half island, and half peninsula—very accurately.

A good hour may be spent sitting on the summit of the tower, gazing on the changeless ocean before you, the changeless rock and Mount beneath you, and their changeful histories known on the Mount—changeful from barbarian Britons to bigoted Benedictines, from bigoted Benedictines to booted cavaliers, and from booted cavaliers to spectacled antiquaries, strange sightseers, and uproarious pleasure-takers.—But now we depart.

A very strong tide against us, occasioned some difficulty to our boatman in landing us again at the pier. The St. Michael's Mount of Normandy is not so lofty or picturesque as that of Cornwall; but the building on the summit of the former, would seem, from several views in the castle we have just left, to be more elaborate and extensive than that on the summit of the latter.

PENZANCE.

We now walked round Mount's Bay to Penzance—a beautiful sea-view walk it is; keeping St. Michael's Mount diminishing behind you, and Penzance, with its well-slated roofs and long lines of building stretching along the shore, and rising up from it landward. This last town to the west is the one most commonly known to invalid visiters to Cornwall, since, from the singular purity and mildness of the air, it has been a frequent resort of pulmonary patients. It is also now associated with the name of Sir Humphrey Davy, the great chemist. The town is good, and, next to Truro, perhaps the best in Cornwall. There

are some fine granite public buildings, as the Town Hall, and an abundant market, especially for fish, an excellent supply of which is obtained from the adjacent fishing town of Newlyn. The Newlyn fisherwomen were said to be remarkable for their beauty and jetty curls, but we saw no traces of beauty in them. Penzance is well known to have been the birthplace of Sir Humphrey Davy.

Much, too, has been said of the nursery-grounds, roses, and myrtles of Penzance; but we observed little to compare with the Guide Book's accounts. The largest nursery is Fox's, near the town, where we certainly found myrtles in the open air, and facing the sea. In the town is the Museum of the Geological Society, containing some good local specimens; but at our visit not very well arranged or labelled. Some rich specimens of the county minerals are there; and, if the visiter wishes to purchase such things, there is a dealer in the town who will supply him with good specimens at a good price, and far too good a price for my pocket, though I fear I coveted the specimens. Fish and other provisions are cheaper than minerals, and few persons care much about the latter.

While at Penzance I should give an account of a mine now indeed unworked, but formerly worked under circumstances more singular than any other mine. Indeed, Huel Wherry stands alone in mining history, and is a striking proof of what human industry will accomplish, and where it will venture in quest of gain.

HUEL WHERRY, A MINE UNDER THE SEA.

Not only have mines been excavated in hills and valleys, some have actually been carried under the sea! They prove, in a striking manner, the miner's perseverance and defiance of danger. I shall soon give a separate description of the famous Botallack mine, from a personal visit and local inquiry; but I here notice what was, perhaps, the most singular work of the kind, and executed more than a century ago, in the midst of the sea, near the town of Penzance.

In this place a gravelly bottom was left bare at low water. Here a multitude of small veins of tin ore crossed each other in every direction, through elvan (porphyritic) rocks. The adjacent rock also contained the mineral, and they worked this rock whenever the sea, the tide, and the season would permit, until the depth became unmanageable. The rocks, after being worked to a few fathoms, were finally abandoned. About the year 1778, a poor miner, of the name of Thomas Curtis, was bold enough to renew the attempt. The distance of the shoal from the neighbouring beach, at high water, is about 120 fathoms, or 720 feet; and this distance, in consequence of the shallowness of the beach, is not materially lessened at low water. It is calculated that the surface of the rock is covered about ten months in the year, and that the depth of the water upon it at spring tide, is nineteen feet. A very great surf is caused, even in the summer, by the prevailing winds; while, in winter, the sea bursts over the rock in such a manner as to render useless all attempts to carry on mining operations. Yet all these difficulties were to be overcome by a poor man! As the work could only be prosecuted during the short time the rock appeared above water—a time still further abridged by the necessity of previously emptying the excavation already made—three summers were consumed in sinking the pump shaft, which was a work of mere bodily labour. As machinery could then be used, a frame of boards being applied to the mouth of the shaft, it was cemented to the rock by pitch and oakum, made water-tight in the same way, and carried up to a sufficient height above the spring tide. To support the boarded turret (which was twenty feet high above the rock, and two feet one inch square) against the violence of the surge, eight stout bars were applied in an inclined direction to its sides, four of them below, and four, of an extraordinary length and thickness, above. A platform of boards was then lashed round the top of the turret, supported by four poles, which were firmly connected with these rods. Lastly, upon this platform was fixed a winz for four men.

By such an erection, it was expected that the miners would

be enabled to pursue their operations at all times, even during the winter months, whenever the weather was not particularly unfavourable. But, as soon as the excavation was carried to some extent in a lateral direction, this expectation was found to be fallacious; for the sea-water penetrated through the fissures of the rock; and, in proportion as the workings became enlarged, the labour of raising the results to the mouth of the shaft increased. The great fault was, that all who had worked this mine had carried on their operations too near the surface, which not only made the rock more permeable to the waters, but also less able to resist the immense pressure of the high tides, so that it became necessary to support the mine with large timbers. To add to all this, it was found impossible to prevent the water from forcing its way through the shaft during the winter months, or, on account of the swell and surf, to remove the tin-stone from the rock to the beach opposite. Hence the whole winter was a period of inaction, and the regular working of the mine could not be resumed before April. Nevertheless, the short interval which was still allowed for labour below ground, was sufficient to reward the bold and persevering projector, and to give his mine the reputation of a very profitable adventure. "Whether he ever felt a conviction of the possibility of removing so many obstacles to his complete success, I know not," says Mr. Hawkins, "although there is reason to suppose he did; for, when I asked his opinion of the scheme of erecting a light-house on the tremendous Wolf-rock, he professed his belief in its practicability, but suggested, as far preferable, the blowing up of the entire rock, which he readily engaged to perform for a proper remuneration."

The state of Huel* Wherry mine, in the autumn of 1791, was this:—The depth of the pump, shaft, and workings, was four fathoms two feet; breadth of the workings, eighteen feet. The roof was worked away in some places to the thickness of three feet. Twelve men were employed for two hours at the winz in hauling

* The Cornish word *Huel*, generally spelled *Wheal*, appears to mean a *hole* or mine. It is the common prefix of the names of many mines; thus, Huel Fanny, Huel Virgin, &c.

the water, while six men were teaming from the bottom into the pump. The men worked in the rock six hours afterwards—in all, eight hours. Thirty lodes of tin-stone were broken every tide in the average. In the space of six months, ten men, working about one tenth of that time, broke about £600 worth.

The workings were confined to a course or channel of elvan, a porphyritic rock, about eighteen feet in breadth, which runs N.W. and S.E., and underlies one foot and a half in a fathom to the S.W. It is discoverable on the beach at half-tide. Besides the small veins of tin which run through this rock, its mass was impregnated with tin to such an amount as to be worth the expense of raising. Fifteen feet of the eighteen which composed the elvan in breadth, produced 1000 cwt. of "white tin" in 1600 sacks; and another foot as much as one cwt. of white tin in every sack.

When closely inspected, the mass in which the tin is thus abundantly dispersed, appears to contain grains of tin of a crystalline transparency, and so equal in size and regular distribution, as to form, as it were, one of the constituent parts of the porphyry. Not unaptly, the term stannified granite was applied to it—which the plain reader may call tinnified granite. This is said to have been the first tin-stone in Cornwall that has been burnt before it was sent to the stamping-mill. A common limekiln having been erected for that purpose, it was found to answer completely; and the object of this operation was to make the stone more friable in its texture.

Mr. Davies Gilbert (a well-known patron of science) wrote as follows to Mr. J. Hawkins in September 1792:—"The course of the stanniferous porphyry near Penzance (the Wherry), promises to make a very great mine. There are indications of the tin being continued to a great extent in both directions, and the bottoms are growing longer, and remain rich. A house near the green, built with fragments of this stone, which were probably picked up on the shore, or broken from the top of the rock, is, I hear, to be pulled down and rebuilt with other stone, for the sake of the tin in the stone. An adventurer told me that £3000 of tin had been raised from this extraordinary mine in the course of the present summer."—In a subsequent letter, Mr.

Gilbert says, "A steam-engine is erecting on the green opposite, and they are constructing a wooden bridge from thence to the rock, to serve as a communication till the engine shaft has been sunk sufficiently deep, and a drift worked out to the river, as a stage for supporting the sliding, or rather hanging, rods." The bridge, thus constructed, answered also the purpose of conveying the ore and *deads* to the shore. The mine was constructed in this manner, and ore to the amount of £70,000 was raised from it. Nor indeed were its treasures exhausted at its close, which was as romantic as its commencement. An American vessel broke from its anchorage in Gwavus Lake, and, striking against the stage, demolished the machinery, and thus put an end to an adventure which, both in ingenuity and success, was in all probability unequalled in any country. This mine was worked again a few years since; but although a very large sum of money was expended, and although all the advantage of the application of improved machinery was found, yet it failed to be a profitable adventure, and was eventually abandoned. This should be a lesson to adventurers; for a few working miners sometimes obtain in the *first* working of a mine, with little capital, far more than a wealthy company with large appliances can afterwards secure.

Some rare minerals, or rare varieties of common minerals, were found at the Wherry mine; amongst others, some valuable ores of cobalt occurred, but these were cast aside owing to ignorance, and lost. Even within the last few years, good specimens of tin-white cobalt have been collected from the crevices of the rocks, a short distance above the town water level.

THE TIN MINES OF ST. JUST AND ST IVES.

Being about to depart for St. Just, I may speak of the district as a mineral tract. The mines of St. Just are (except Levant) chiefly tin, and comprised within a district of the north-western coast of not more than three miles long, and one mile and a half in breadth. Of its minerals, bismuth has been found,

in Botallack and Levant mines, and iron ores in great variety, also some cobalt and pitchblende. The direction of the veins is a remarkable feature of this district, and will be spoken of when treating of lodes and their directions. Here it will suffice to say, that the metalliferous (metal-producing) veins bear from north-west and south-east to north and south; while the "cross veins" run about north-east and south-west, or not very different from the direction of the metalliferous lodes in other parts of the county.

In this district the chief mines are the Botallack tin and copper mine, to be presently described; the Levant copper and tin mine, which, including some old mines in St. Just, has left a profit of more than £150,000 in the last eight years. The copper ore of this mine is the richest in Cornwall, and the mine returns small quantities of tin. They have here an engine of forty inch cylinder, and four "steam whims." The adit is twenty-five fathoms deep, and the lode is more than 220 fathoms deeper than the adit; the most productive part of the mine being under the sea. The steam-engine is situated on the top of the cliff in a very romantic and striking manner. In eight years, ending June 1842, this mine had returned 21,374 tons of copper ore, yielding £255,538, besides large quantities of tin.

St. Ives Consols tin mine has been at work some thirty-eight years, and is very rich for tin, and has made large profits. The monthly cost was £2400, and the number employed was 450 persons; but if tin be at a low price, the mine barely pays expenses. The formation of the tin ore in this mine is very singular, and is provincially termed *carbona.* It exhibits but few of the usual characters of a lode; it is bounded above, below, and on either side by the usual granite. The whole may be described as a network of *pipes, strings, branches, shoots,* and *veins* (to use the terms of miners), converging into one grand trunk, which extends to the south-east, and dips in the same direction at the rate of about one in six.

Of Wheal Vor tin mine, I shall give some statements under the head of mining risks and speculations. The Godolphin,

Perran, and Great St. George's, and Polberro tin mines, are names well known to miners.

In the Wheal Penrose lead mine, the British Silver Lead Company, having purchased it, expended upwards of £100,000 on that and Wheal Unity mine, and returned a large quantity of lead, and some copper. In Wheal Darlington tin and copper mine (in Ludgvan), the prospects were very good, the return in 1851 being 7435 tons of copper ore, for £48,308. Three hundred persons were employed.

The mines of Marazion afford an important history of serious losses, which will be mentioned to illustrate mining speculation and its reverses.

CAPE CORNWALL: NIGHT THOUGHTS AND THE OCEAN.

Departing from Penzance, and travelling six and a half miles in a north-west direction, we arrived at St. Just barely in daylight. One inn alone was open to us, and that more of a public-house than an hotel. We got up-stairs into a "private room," but neither privacy nor quiet had we that evening; for a band of musicians, composed chiefly of miners, were parading the neighbourhood for practice, and for drinking afterwards. In the north of England I heard a band of musical pitmen in a pit village; there, near the extreme Land's End, I encountered a band of musical miners. It was pleasant to witness their enjoyment; but the sound was not calculated to calm an agitated mind, and the drum had a fearful power. They might almost have heard it at Penzance.

After tea, and after sunset, we both walked out, and strolled along seaward over turf and moor. It grew dark, and still we went onward, ever nearer to the sounding ocean. We knew that we were approaching Cape Cornwall, for St. Just is directly behind the cape. There was no light but that of the stars, which began to shine out thickly, lighting their golden and glowing lamps in rapid and flashing succession. We got a little romantic, and so *would* persevere in nearing the ocean, though

we did not feel satisfied as to our safe footing in so doing. Louder and louder sounded the billows; soon the hoarse, hollow boom of the far off sea began to grow distinct, and this booming was interrupted at short, regular intervals by the hissing dash of the waves broken upon the lashed shore. Then came the sweeping, rushing sound of the retiring waters—then a pause; then another boom, and dash, and hiss, and a retiring rush—all convincing us that we were near the shore we could not see.

The night was starlight, but we could not catch more than a few faint gleams of the clamorous deep—glimmering faintly far beneath us, and inspiring a strange kind of awe and interest. A long fixed gaze seaward at last showed a light—it was doubtless that of a lighthouse—then it was again hidden, and we heard only the sounds, and saw nothing. I am perhaps singular in my feeling; but I cannot divest myself of a kind of uncomfortable awe at such a time and such a place. I never felt such an awe elsewhere, even when more than a thousand feet under ground. The kind of fear I feel at such a time and place as I am describing, is peculiar. In fact, the only occasions in which I have been, as far as I can remember, conscious of a creeping tremulousness, have been night hours on a wild sea-coast. I remember full well at this moment the thoughts present at the dark hour when I stood on the verge of Cape Cornwall, on ground as yet unseen by daylight, and unknown to me. My companion was there, but I spoke little—scarcely at all. There was I, near the end of my country's soil, standing on ground I conjectured to be rock, covered with short furze or heather. There lay before me the boundless, booming ocean, audible though invisible. Was this not like the verge of my life? Would it be so with me at the end thereof? Should I have been journeying through life as lately through this county, diverting myself with little pleasures, and vexing myself with little crosses; gathering up a few experiences, studying a few favourite sciences, changing a few localities, greeting a few friendly folk, and avoiding a few morose people; making a few bargains, and travelling onward by short stages; forgetting much, deceived and beguiled by trifles, and at last brought suddenly in the darkness

of night to the point at which land is scarcely left, and where the great sounding but invisible ocean of Eternity bursts clearer and clearer with its unceasing chime on my startled ear?

And then—and then—what is before me? What is *that* ocean? what its character? I strive with keen eagerness to pierce into its darkness—the darkness spread over its interminable face! No light is permitted—all is invisible—save those momentary gleams of sea-shining that touch the troubled eye one instant, and then roll off into the surrounding gloom! The very sound becomes more awful because of its regularity and increase. On that ocean I *must* launch—*soon—soon!* I would turn back to daylight and familiar faces, to the faces and scenes I left this very day. No! onward—onward—onward!

Memory becomes lively. Facts and events crowd into the mind, thick and luminous as those countless stars overhead, all unseen an hour ago. Life itself comes back like a reversed tide—boyhood, youth, manhood. The vanity of life comes back—broken resolves, baffled plans, disappointed expectations, blighted affections, losses of indolent days, of foolishly occupied years, of things I *might* have done and *meant* to have done, of conceptions worthy enough and holy enough—all vanished in mere reverie! O! crowd of incomplete, uncouth, half living, half dead designs. O! ye mockeries of myself. O! ye ghosts of good thoughts and deeds indifferent. O! ye snatches of lofty song, and of weighty prose, and of Scriptural truth. O! ye living but lost principles. O! ye reanimated ghosts of good intentions. O! ye unbenefited fellow-men, ye unroused sensualists, ye business-besotted citizens, ye unwary youths, ye giddy fashionables, ye foolish, giggling triflers—yes, ye may all stare at me hideously and scornfully now, through this misty gloom! ye may mock me now, I can do nothing to save you—nothing more! I hear and dread the eternal ocean! I might have said words, and done deeds, and written books, all to warn you, and make you wiser and better; but now it is too late! Though my resolves have been numerous as the billows of the dark interminable sea before me—what avail—what avail? One more step, one more step, and all is over! Yes, all—but——

"Hollo! L——," exclaims my companion, "how mute you have been! it is high time we got back to the inn, if we can find our way. Ah! there's that outrageous drum again; we have only to follow its course, and it is sure to lead its owner to the tap-room, somewhere below our bed-room."

I rub my eyes, look up at the stars, and away we trudge back again. In looking on the ground we find a remarkable crowd of *glow-worms* scattered all over the moor! We take up several, and both observe we never saw such a sight before. What with the sea before us, what with the stars above and the glow-worms below, even without reference to my thoughts within—this is a strange and memorable night's walk!

Let us go to sleep, and forget all sombre thoughts; but, alas! my companion's prophecy of the drum is too true, and doubly accomplished; for the whole band comes into the tap-room, and having tried most hideous solos on brass instruments, they drink deeper and deeper, and then break out into a vocal expression of their love and good wishes for Cornish lads and lasses, that leads us once more to wish devoutly for the drum, by way of preference. Finally, about midnight they rise up, and try to march off playing "God save the Queen," as aforetime. Had the queen heard it as we did, nothing could have saved her; she must have gone mad that night! for trumpet, and French horn, and clarionet, and fife, and bassoon, and drum, seemed all to have broken the temperance pledge, and got fearfully drunk together!

After having dreamt of sounding oceans and sounding drums, and heard instruments of discord all night, I got up very early in the morning, and stole out alone, and again traversed Cape Cornwall. What different sensations were mine in that walk! The night before, all was romantic gloom and fearful foreboding. But now the sun had replaced with his single blaze the routed host of hidden stars. Glow-worms had paled their ineffectual fires, and clear dewdrops hung upon the little furzes, under which the glow-worms had shone brilliantly in the preceding darkness! And now I stood somewhere within probably a few hundred yards of the spot which I had occupied the night before. Full, broad, and boundless before me rolled that terrific

ocean of the previous night—now calmer, quieter, and breaking out, for uncounted leagues, into those dimpled smiles beneath the brightening sun, which even old Æschylus had enjoyed, and sung in Greek, long centuries ago.

What a sight was this shoreless Atlantic—and how bold was the coast of the Cape! But now I was joined by my friend, who thought more of breakfast than breakers, and so I must defer further description until after this meal. We cast a glance at the tap-room as we re-entered the inn—a melancholy end of all musical midnight orgies! I fancy that drum and those discordant brazen-throated instrumentalists will be so penitent this morning, that every one of them will solemnly and soberly renew the pledge. Happy event for the future lodgers in that sleepless bed-room!

As to St. Just itself, it is a "church town," as all places in Cornwall having a church appear to be called. As to its scattered population, they seem to subsist or depend upon the neighbouring mines. Now we walk in the direction of Botallack, to see the wonderful mine there; and, on the road thither, we observe the Cape head grouped with two sister rocks in a most striking whole. We soon reach Botallack, which is the name of a promontory not far from Cape Cornwall. Here is situated a mine, the most singularly placed probably of any mine in the world. Let me now describe it.

BOTALLACK MINE—UNDER THE SEA. DESCENT AND DESCRIPTION.

Botallack mine is really one of the greatest sights in Cornwall, to a visiter curious in the triumphs of art and industry, in connection with bold scenery and magnificent marine views. It is a copper mine; but tin and iron are found there. It is established at the western extremity of the great copper and tin lodes, conjoined with lead, running eastward through Cornwall as far as the Dartmoor hills. This portion of Cornwall comes within the great metalliferous district of the county, and has

been well studied as to the mineral veins and their directions. These veins run through the granite that prevails towards the Land's End, and they are found penetrating the cliff at Botallack, so that nothing but the sea—the swelling Atlantic—seems to cut them off. If you know veins by sight, you may trace them running along the rocks into the sea; they appear to grow even better at the very sea-verge, and if men could but cheaply break down that immense mass of precipitous rock which beetles over the ocean here, they would have a richer harvest of copper than has yet been gathered by the slow operation of more than a century. The great gains, however, belong to the earlier history of this mine. At one period, it left a profit of £300,000. Even about ten years ago it was very profitable. The veins have now become thinner and poorer in the direction in which alone they can work them, and the price of copper had fallen until very recently, when it has again risen. The mine was formerly worked only for tin, and was nearly abandoned in 1841, when copper was found.

When first established the capital expended must have been very large, since the natural difficulties of situation greatly increased the ordinary expense of erecting machinery and mining gear. The separate parts of an enormous steam-engine were lowered 200 feet down the almost perpendicular cliff, and a tram-road is seen running right up the face of the cliff.

Standing below the cliff and looking up from the sea, the view is fearfully grand, and remarkable for the combination of the wonders of art with the wonders of nature. On the very summit of the beetling cliff you behold the mining apparatus overhanging the sea. You see a chimney smoking loftily at the tops and another puffing less loftily about half-way down. Then lastly, closer to you, and almost close to the sea, is a third smoking chimney, connected with a small mining office. On one side of the cliff tall ladders enable the miner to ascend, and he must have a sure foot and a strong head who can comfortably tread those ladders, round by round, the sea roaring under him, and almost flinging its raging spray after him as he gets higher and higher! Taking in the whole apparatus in one view;

chains and pulleys, chimneys and cottages, posts and winding machines—seem to be scattered over the face of the whole cliff, like the spreading lines of an immense spider's web; while in some parts mules and their riders may be observed to be trotting up and down the rocky tracks, that the pedestrian visiter would scarcely dare to pass. You turn dizzy and even faint in looking up at them; you give your fancy wing for one moment, and you think you see a company of Spirits belonging to the ranks of the powers of the air, who, for the special purpose of mocking poor fettered man, are scaling precipices, and dancing on rocky needles, and skipping up fancy ladders, and snorting and puffing from hidden fires, and disembowelling the martyred earth, and forging thunderbolts, and diving suddenly under the indignant, hissing ocean, and spiriting away hidden treasures, and punishing a host of poor culprits, by imposing upon them incessant labours amidst unearthly perils and unearthly companions!

You gradually recover from your day-dream, and, going up to some of the men to see that they are of the same flesh and blood as yourself, and to the mules to see that they are as mulish as most of their species, you suddenly conceive the bold design of visiting for yourself the subterranean, or rather sub-oceanic, excavations in this extraordinary mine.

To gain even the entrance of the mine is no slight matter. You do not go straightly and evenly to the shaft's mouth, as in other mines on level ground. But you have to pick your way down to a small counting-house, erected on a cliff or prominence half-way between the summit of the rock and the ocean. You must first go there to find the mining agent who will accompany you. What an accumulation of mining gear you must pass! long chains stretched out over bell-cranks and posts—wooden platforms looking like battered remnants of wrecks—and yet supporting large beams of timber and heavy coils of rope. Here, there is a little, creaking, crazy-boarded shed—there, a broken-down post or two—and there again, you must wind round by the rocky path amidst chains and cables and ascending loads.

Having obtained permission and guidance, you attire yourself in a woollen mining dress, and putting on a large felt hat, and

tying three or four candles to your buttonhole, while you will have to carry another lighted in the hand, you now ascend the cliff, walk along a while, and gain the trapdoor entrance to the mine; you set your feet on the staves of the first ladder of the engine staff—now, take note of the accessories of the situation. Over the dark vacuity beneath, in which a double row of iron pumps are lost in gloom, you observe, on one side, the huge beam of a steam-engine, which every instant is alternately bowing down and then rising, heavily straining at the deluge of water which it lifts; on the other side, through boards—the chinks of which admit just light enough, at the foot of one of the ladders, to show the passage—you see the loaded kibble, or bucket, rushing past its descending companion. You are now between two shafts, descending from stage to stage. Quickly losing sight of the daylight, you depend on candles alone, which throw but a faint and mocking light into the gloomy abyss on your left, and beneath your feet. After descending two or three ladders, almost perpendicular, you are indulged with a momentary halt on a platform, while your sturdy guides wonder at your weakness. Now, again, place your best foot downmost on the ladder, lay strong hold on the clayey sides of the same, have a candle stuck in cap front, if you can wear it, and be as bold in your down-going as any prudent man can be that knows he is certainly going down in the world, but does not know how far down he really is going, or whether by any conceivable amount of energy he shall ever get up again!

Another ladder? yes, another and another! Well, but what are you to see at the bottom of all these ladders? Nothing more of any general interest than what you see where you are—except that you will find the end of the lengthy pumps in a sump or reservoir of water drained from all parts of the mine. But you may turn into a level here upon the lode—*i. e.*, a side gallery, and traverse it, and you soon find that you are in one of an apparently endless series of galleries some six or seven feet high, through which two persons (if thin) can just squeeze past each other, and where debtor and creditor would not exactly agree to meet, at least as regards the debtor. It is no pleasant thing to

find many of these galleries terminated by dismal trap-holes, which lead to nothing but headlong destruction!

But go on from gallery to gallery; you may as well see, and feel, and fear, all there is to see, feel, and fear. Never heed a bruised side, a battered rib, or a broken cap, the only thing to fear is a broken head.

Just step over the rough stones and the awkward holes, and just stoop down under the depending lumps of rock overhead, and climb with contrary agility over the rocky eminences beneath your feet. Your progress in a mine is never equal or similar, but is ingeniously compounded of walking, stooping, crawling, crouching, descending, climbing, creeping, and grumbling!

Pray, have no fear of those unknown abysses, but thinly covered over with planks, which you must cross every now and then in these levels. True, the planks are shaky and slippery and slight, but the quicker you get over them the better. As to the hot, sickly, damp vapour which floats about you, made visible by your candles, it can't do you much harm for one short hour of a single day. Perhaps, if you had to breathe it eight hours every day, as a miner, you might justifiably grumble, but go on now, the perspiration will do you good—"On, Stanley, on!" As to the mud, tallow, and iron drippings which are visible on clothes, cap, and face—why, though not cosmetics, they are harmless. And now you come to a miner with a short pickaxe labouring at the ore—you must give him sixpence and get a bit of ore, which you can show as broken out by yourself. Go on, and you see other miners working with pickaxes—and give other sixpences if you can afford it. And now you inquire the distance you have come, as you are invited to rest on a bit of broken board carried for your convenience. You are impressively informed that now you are twenty fathom—one hundred and twenty feet below the sea level, vertically; and horizontally four hundred and eighty feet under the bottom of the ocean, or below low water mark!

Proud moment this to you—never to be enjoyed in any other mine! Yes, "four hundred and eighty feet under the ocean," repeats your guide—why, boats and vessels are sailing over our

heads—while still, deeper down, human beings are working under our feet! What an unprecedented position—overtopped by the sea, undermined by the miners, walled in by rocks of unknown thickness!—Let us look on our metallic ceiling—lift up the candles that are going into a galloping consumption. Light another; you can stand up here, and mark the dull stripes of pure copper running confusedly amongst the rocks. But what makes the rock so damp and dripping here, and not elsewhere? what? why, *the sea* percolating through it, granitic and close as it is, and producing masses of ooze, green and glistening, and half lining the roof, as if we were in a Neptunian cell or grotto. But this is nothing. In storms and tempests, our guide has felt it showering down upon him in a complete and continuous spirting of sea water; and, moreover, this rocky partition has been worked so thin, that the little log of shaped wood up yonder, which the guide points out in the roof above us, has been plugged in to preserve the developement of a positive hole upward to the ocean! "Pray, guide, how many feet, do you think, of thickness of rock we have between us here and the sea?"—"Why, gentlemen, I should say about five or six feet here, and about three or four feet at that plug there." Well, here is a situation indeed!—no wonder nobody thinks of getting another pound of metal from that roof, rich as it is beyond any other portion of the mine! We will, however, give that miner one shilling for the bit he says he has positively struck out only three feet below the water. A suitable present this from a husband to a wife, to show how brave a man he has been while absent from her, and thinking of her under the sea!

But if the ocean is so near us, can we not hear something of it? Let us listen in perfect noiselessness for a few moments—listen—hush—hush—ah! don't speak, but listen—yes! it comes, it comes upon the ear like the faint dying echo of the loud hollow booming we listened to last night near Cape Cornwall. It comes like the remembered sound of a rolling surge—like the swell of the ocean's diapason from a considerable distance—partly like the sound of wind outside a house on a stormy night, but far more regular—more majestic—less wild. It has a me-

lancholy majesty in it—it has a spiritual impressiveness in it. It does not threaten, but subdues into humility and meekness. One moment there is a harsh grating in it—that arises from the rolling up of some loose stones; and now all is melancholy and solemn again. In truth, we only hear the sound of distant waters, lashing rocks 120 feet above us.

OTHER SUBMARINE MINES.

But there are other submarine mines in this vicinity; though not much known. In the mines called Little Bounds and Wheal Cock, as well as Botallack Mine, the hardihood of the miners has tempted them to follow the ore upwards even to the sea. But the openings made were very small, and the rock being extremely hard, a covering of wood and cement in the two former sufficed to exclude the water, and protected the workmen from the fatal consequences of their rashness.

"In all these mines" says Mr. Henwood, "and in Wheal Edward and Levant, I have heard the dashing of the billows, and the grating of the shingle overhead, when in calm weather. I was once, however, underground in Wheal Cock during a storm. At the extremity of the level seaward, some eighty or one hundred fathoms from the shore, little could be heard of its effects except at intervals, when the reflux of some unusually large wave projected a pebble outward, bounding and rolling over the rocky bottom. But when standing beneath the base of the cliff, and in that part of the mine where but nine feet of rock stood between us and the ocean, the heavy roll of the large boulders, the ceaseless grinding of the pebbles, the fierce thundering of the billows, with the crackling and boiling as they rebounded, placed a tempest in its most appalling form too vividly before me ever to be forgotten. More than once doubting the protection of our working shield, we retreated in affright, and it was only after repeated trials that we had confidence to pursue our investigations."

I inquired eagerly for men who had been present in those

mines in storms; but I could elicit nothing more than a few general expressions of awe from one or two miners who had. It seems that, at times of great storms, even the *habitués* have been terrified by the fierce and threatening roaring of the sea, and have quitted the scene in affright. They have heard, as it were, mountain dashing against mountain; and one old man told us he heard the sea, when in Little Bounds, like cannon-balls above his head. I thought I would come specially to this spot on such an occasion, but as yet have never done so. The miners seem to have perfect confidence that the rocky shield, thin as it is in some parts, will defend them against the incursion of the Atlantic; and all we can say is, that it has defended them hitherto.

We may as well reach the daylight once more. We have only to scramble, crawl, walk, creep, crush, climb, and grumble as before, and we shortly behold the bright sunlight, and are fanned by the refreshing breeze of that ocean, the echo of whose sound we have so faintly and yet fearfully heard under its depths. At the counting-house, gallons of water are awaiting us, and tallow, mud, ooze, and iron-rust, all give way to the application of soap. Off go our miners' caps, and woollen jackets, and wide inexpressibles, and away we go too, having received many thanks for the half-crown each of us has left wherewith to drink our health under the sea.

Yet we will take one more look from the sea-margin upwards, and watch the whole outward machinery. When shall we see such a curious spectacle again? Now we observe that the ore extracted from these wonderful sub-oceanic excavations is dressed on the side of the cliffs in a landing space, and drawn up, after being "spalled" or broken, along the precipitous tram-road that climbs the cliff. Strange sight—to watch the steam-engine smoking at the top of the cliff, and the little loads of broken ore running up the face of the black rock at its bidding! When the ore arrives at the summit, it is stamped and separated by two wheels and hoppers.*

* As an instance of the inaccuracy of a late popular work on Cornwall, I may mention that Botallack is there said to pay scarcely any thing to the shareholders,

In "Our Coal and our Coal Pits," p. 132, I have mentioned the submarine excavations at Howgill coal pits, west of Whitehaven, where the mining has been carried more than 1000 yards under the sea, and about 600 feet below its bottom.

THE BLIND MINER OF BOTALLACK.

A very remarkable story has been told respecting a man who once worked in Botallack. A blind man (whether blind from birth or accident is unknown) became a labourer in this mine. He continued his perilous toils underground for a long period, from the dread of being compelled to accept parish relief. By the fruits of his labour he supported his family of nine children; and such was his marvellous recollection of every turning and winding of this subterranean temple of human industry, that he became a *guide to his fellow-labourers,* if by any accident their lights were extinguished! It is painful to add, that on being discharged from this employment (and they must truly have had rocky hearts who did discharge him—*heu, auri sacra fames!*) this poor blind man soon afterwards met his death in the following melancholy manner. Being engaged as attendant on some bricklayers who were building a house at St. Ives, it became part of his duty to carry the hods of mortar up to the scaffolding, from which, having taken a step too far back, he fell, and received such severe injury on the head that he almost immediately expired.

It was this honest man's boast, his chief comfort in blindness, that he never asked assistance from his parish. Of him it was sung:—

For him yon landscape all is dark,
  Yon seaward view no beauty yields;
No sunset glory can he mark
  On far-off waves or neighbouring fields.

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whereas it is now one of the highest priced mines in the share-lists. Looking at the share-list on December 31st, 1853, I find that the present price of a Botallack share is £387, the originally paid amount of a share is £91, 5s., the dividends received being very considerable. In 1852, the dividends increased by £1050 over the dividends of 1851.

But *Home*, the blind man's peaceful home,
Glows in his heart as on he goes;
The voices thence in music come,
Singing of love and sweet repose.

He cannot see, but oh! he *feels*
The fair young cheek that waits his kiss;
That sparkling eye no light recalls
To him, but all its beams are *his*.

His spirit swells, his virtue high
His children mark, and catch its glow,
While gazing on his darken'd eye,
And gladden'd by his smile below.

'Tis joy, 'tis joy! though not for him
Doth the glad face of Nature shine;
His spirit is not sad or dim,
Nor will that noble heart repine!

THE LAND'S END.

The Land's End is but a good walk of four miles from St. Just; but they who have had a scramble and climb in and around Botallack, are not good for much for the whole day after. Well, then, we will hire a posting vehicle to the Land's End. Very good if one there be; but none there is. What, no private carriage, phaeton, or gig? not one for hire! We go round and inquire, but the people seem to wonder we don't walk. But we cannot carry our bags. Then hire yonder cart to do that for you. We engage the cart, put our bags on it, and trudge after it, literally like Goldsmith's traveller—

"Remote, unfriended, melancholy slow."

Little but sea view is before you, and it is a dreary walk to Land's End. You keep rather inland, and have the sea on your right. You stretch away over heathery moor and prickly furze, broken by large stones scattered wildly all around. Now you catch a glimpse of the sea, and of steep abrupt promontories just over it. Then again you must turn more inland. Not a solitary human being do you meet; you find the cart-driver silent and reserved. An old horse staked down by his rough

rope looks askant at you as you pass; sheep look up from their luscious short grass, with tinkling bells; your companion, too, has become moody; and, while you are getting quite melancholy at the aspect of affairs, the cart-driver breaks in with a word or two, and pointing with his half-whip to a rocky edge on your right, he exclaims:—"The Land's End; where shall I put your bags, gentlemen?" Where, indeed? There is a house or cottage some distance up there on the left; let us go up to it; we'll put the bags there. "Now, driver, there's your money. How often have you been here before?" "Only once afore, sir." "Only once?" "Only once, sir, though I have lived at St. Just all my life, man and boy!"

Up comes a weather-worn guide to the Land's End. We consent to hire him, and down we go seaward. At length we leave the grassy moor, and travel on the stony ledge of a high cliff. Rocks after rocks in graduated succession stretch down pointedly to the ocean—dark-hued, and in some places almost black, except where they are out of sea reach, and overgrown with lichens. Granite is the material, but the action of the sea and storms has given it a basaltic appearance, and made it look more jagged and pointed than granite in general. And this is the LAND'S END!

Finding that, advance as I will, there is still another "Land's End" beyond, I become foolishly adventurous, and, despite of my companion's tender allusion to those I love best, and who love me best, I still crawl onward over jagged points of rock. There are now only one or two considerable masses of rock visible beyond me; the guide somewhat slowly goes first, and I follow, until I really stand as veritably upon the Land's End as any human being can safely do. Here I gain a magnificent oceanic view, the broad, shoreless Atlantic beating up to the western extremity of the land of Old England. The eye gets tired of looking long upon an unvaried oceanic scene. No land before you—even the Scilly Islands (the ancient Cassiterides) being invisible except on a clear day. But now I turn my eye landward, and I behold the massive rocks here and there arched out by the sea; and, it being high water, they present a majestic

appearance. One vast projecting mass is named by the guide "Dr. Johnson's Head," for what reason it is not easy to pronounce.. As I return to my more prudent companion, the guide directs my attention to the print of a horse's hoof in the scant herbage at the top of one of the rocky edges. This, if you credit the guide, is the spot where a fool-hardy rider just saved his life by jumping off a poor horse he had, for a wager, spurred up to the utter verge of the Land's End: the horse, meanwhile, rearing and falling backwards into the deep Atlantic Sea!

Tea was the best thing we could think of ordering at the only inn we could discover. It must have grown on the Land's End as herbage, if judged by taste and strength. The inn, latterly much enlarged, has two inscriptions, one on the part towards the sea thus—"The First Inn in England;" the other, on the back of the house, meeting the eye of the traveller coming *to* the Land's End from Treryn, thus—"The Last Inn in England." I leave the reader to judge for himself of the modesty and truth of these inscriptions, and of that of the figure 1, on a neigbouring old milestone, which our guide declared was the "only original first milestone in England." Next we are bound for a notorious curiosity in Cornwall.

THE LOGAN OR ROCKING STONE, ITS FALL AND RESTORATION.

This remarkable stone lies about three miles back from the Land's End, at a place called Treryn, or Trereen, on the coast.

The Logging or Logan stone is situated on a peninsula of granite, jutting out about 200 yards towards the sea, the isthmus still exhibiting some remains of the ancient fortification of Castle Treryn. The granite is split by perpendicular and horizontal fissures into a heap of cubical or prismatic masses. The whole mass varies in height from fifty to eighty, or 100 feet. It presents on almost every side a perpendicular face to the sea, and is divided into four summits, on one of which, near the centre of the promontory, the rocking stone lies. The general figure of the stone is irregular. Its lower surface is not quite flat, but

swells out into a slight protuberance, on which the stone is poised. It is about seventeen feet in length, and thirty-two in middle circumference. The vibration is only in one direction.

This stone is an enormous mass of granite, supposed to weigh about sixty-five tons.* The remarkable natural phenomenon attending it is, that it is balanced on the pivot of rock protruding from the mass below it so exactly, that it can be rocked by the application of some force; and hence it is called the "Logan or Rocking stone." That it can be rocked I and my friend do aver, in as much as we climbed up the mass on which it sits adjusted like a conscious sovereign, knowing it is kept there by the "balance of power." When we had gained it with some peril, we both applied our shoulders to the stone. Neither of us having broad shoulders, both of us together had to labour hard for some minutes. After shouldering and straining for a minute or two, we turned round and looked upon the stone—and, lo! it did move—it did!—not by any means so much as we expected or desired. But still we had put the whole sixty-five tons in perceptible motion, and in a gradually decreasing motion it continued some moments. We moved it but little, it is true—about as much, perhaps, as the Russian Czar is moved by appeals to justice, perhaps a little more!

Much of the wonderment and charm ceases when you learn that this rocking stone has been reset in its place by a penitent lieutenant of the Royal Navy, who, in 1824, overthrew it, out of that mischievous malevolence which seems inherent in human nature. The man visited the stone, and having moved it more easily than men can now move it, absolutely called up his crew, placed strong levers under the Logan stone—gave the word of command—and instantly sent the nicely-balanced wonder of nature—the work of centuries upon centuries—tumbling and banging down the crags towards the sea! Luckily for him, for the innkeepers, and for us, the rocking stone ceased to tumble over and over, and obstinately fixed itself in a cleft of the cliff!

Two Cornishmen had been eyewitnesses of this piece of

* This was Dr. Macculloch's estimate in 1814, viz. exactly 65·8 tons.

malevolence, who rocked and rolled over one another in their haste to inform the lord of the manor, and to rouse the natives. A universal execration followed the lieutenant—curses after the Cornish mode clung to his sails, and becalmed or battered or bewitched his ship. Even the Lords of the Admiralty had some sense of the supreme importance of the Logan stone to the safety of the coast and the county. The wicked officer was ordered to restore what he had displaced. He might get materials from the dockyards, but he must do all the rest himself under pain of losing his commission. And now you might have seen immense beams rising up round the vacant granite throne of the fallen chief of the rocks. Up rose pulleys and masts, and hard by you saw capstans and handles and cables and chains, and all to do justice to a stone. However, justice is justice, and no man has a right to dethrone even a popular idol for the mere love of mischief, and for mere malevolence against vulgar idolatry. Besides, all the innkeepers, and their wives and families, their "boots" and chambermaids, and their hostlers and guides and touters—all with a great shout declared—"By this stone we have our wealth!"

The unhappy lieutenant, whose name was, according to my guide, Goldsmith, passed chains and cables round the fallen stone. The immense cranes were swung over it, and now a day was appointed whereon to restore the great idol of the Cornish people to its shrine in Nature's temple. Crowds from far and near assembled. There stood poor Goldsmith, now not cursed but cheered as he looked down to the stone and up to the shrine. All preparations being made, the word was given, and the crane began to groan, the chains and cables to tighten, the beams to bend, the capstan to creak, the men to shout, and Goldsmith to look less anxious. Still the stone barely moved.—Ah! this is more probably the work of a week than of a day. Bad news this for all but the innkeeper. Beds are at a premium, a famine of all but pilchards threatens, and a complete fair is established, with all the delights of a fair. Alas! alas! about the only thing that does not rock now is the stone! Men of gravity, and youths of respectability, visit the tap-room and the beer-barrel,

and reel about, rocking to and fro far beyond any example the Logan stone had ever set them!

Another day, however, sees the Logan stone swinging about in the air, hovering like an eagle over its rocky nest, and finally descending, amidst shouts and cries that scared all the seagulls around upon its granitic pivot. While the rock was suspended ere descending, one man advised a little movement to one side, and, when his approbation was given, the stone was let down, and thereupon the men fell upon their knees and thanked God for safety. Yes, there it sits and rocks—once more and for ever, sensitive to the appeal only of brute force, showing no preference for any, but rocking to the shoulder of the strongest, be he fisherman or gentleman. To prevent a second overthrow, a small piece of iron is sunk into the stone below it, and towards the stone, so that it acts as a kind of bolt to fasten it where it is. On the sides of the stone you still see the holes made for the hooks and chains which suspended it to the crane. It is said that the Logan stone has never wholly recovered the effects of its fall, being less accommodating than at first. Even restored rocking stones, like restored Popes and Sovereigns, are not so movable as they were before they were first unsettled.

ORIGIN OF ROCKING STONES.

Inquiring readers will ask me, how did the Rocking-stone become so nicely balanced at first? Now, sage and learned antiquaries have failed to find this out, and who am I that I should essay to solve the riddle of the rocking-sphinx? Nevertheless, I may venture upon a few hints. As authors are the best commentaries upon themselves, so are rocks the best upon rocks. You will find, after careful examination of the immense "tors and cairns" of the western granitic districts, including Dartmoor, that they are formed of masses better able to resist atmospheric influences than others. Geologists dispute about divisional planes and concretionary arrangements in granite. But from some such structure many parts of huge granitic masses have

been slowly worn away, leaving large spaces, and producing a somewhat cubical structure. What remains was alone able to resist the decomposing influences of thousands of storms and winds, and if only a little peak between two blocks then we have the Rocking Stone.

The Cheese Wring, near Liskeard, in another part of this county, is a mass of five blocks of granite rising to a height of about fifteen feet (thirty-two feet according to Borlase), apparently piled one on the other, the heavier and larger on the smaller and lighter. It is the remainder of a much larger mass, the lateral parts of which have not been so well poised, and fallen away. None of the stones move, because the decomposition has not proceeded far or favourably enough. The "Giant's Punch Bowl," in St. Agnes, one of the Scilly islands, exhibits the same irregular decomposition of two vast blocks of granite piled one on the other. And the "Kettle and Pans," in St. Mary's, Scilly, display large cavities formed by long decomposing processes in masses of exposed rock. In Carnbrea, near Redruth, a whole set of culinary vessels may be imaginatively described out of the numerous natural cavities worn in the big blocks around.

Mr. Bray, when very young, was the first person who explored the remains of British antiquity in Dartmoor in Devon, and upon many of the "tors" he found rock basins, which he considered the work of man. In clearing one of these basins from the moss and mould with which it was filled, Mr. Bray accidentally discovered one of the logan or rocking stones, which he thinks the Druids made so much use of in their priest-craft or law-craft. For want of instruments, his companion kicked away the earth with his heels while sitting on a large flat stone, which measured eleven feet by nine feet, and was divided by a fissure; and at every stroke of his heel, the part on which he sat shook and was heard to strike the rock below.

There is a remarkable Logan stone at Staple-Tor, which requires the application of a counterpoise in order to its being moved by ordinary human force. A logan stone, not generally known, is found on the summit of Rosewall Hill, in the St. Ives district. It weighs about twelve tons.

CORNISH MOOR AND COAST SCENERY.

A walk of two miles brought us to a sleeping house at St. Buryan's, another so called "church town," but in truth a wretched village, though the inn was tolerable, and the people obliging. Anciently this was a town of considerable importance, and the seat of a College of Prebendaries, founded by King Athelstan after his return from the conquest of the Scilly Islands. The church tower stands on the highest point in this part of the county, being 467 feet above the level of the sea, and it is a conspicuous object far around. There is a druidical circle in this vicinity, consisting of sixteen or nineteen stones set up in the centre of a field. Popular superstition affirms that there were once nineteen maidens thus petrified for dancing on a Sunday. The great Cornish antiquary, Borlase, who was a native and vicar of St. Just, may have revelled in luxurious meditation in this very circle of stones. What visions of venerated oaks, and golden knives, and sacred mistletoes, may have risen up before him here in the gloaming of evening, or on the wild moors, and within sound of the ever-thundering ocean! Old Borlase's "Antiquities of Cornwall" is an amusing book, and an instructive one still.

In this place I would hastily sketch some features of the bolder coast-scenery of Cornwall. It is beautiful, I think, as any in England, at least. Do not miss, if you visit Cornwall, these coast scenes of grand rudeness, with monumental stones rising over the shore. If you have time and strength, you will find, all along the coast about the Land's End, and from that towards Penzance, a series of varied and majestic views, soon becoming less and less bold, and more and more beautiful in softness. What pictures might be made of bays and promontories we have passed! Here, rocks rising cubically, perpendicular, and separate, independent as Radicals, and much more solemn and venerable. There, pointed, piercing, weather-worn columns of granite, like Nature's church steeples, with the solemn sound of the oceanic organ beneath

them. There, again, inaccessible crags, like stern popes, with crowns proudly bent over the billows, which clasp their feet with flattering adoration. Here, immense ridges of rock hollowed out into small natural archways, and letting through light upon the dark scarred fronts of the unchangeable cliffs. And here, just at our feet, beautiful smooth shining sands, sparkling with their granite particles, and here and there thickly sprinkled with exquisite little shells of peculiar beauty for an English coast. There, if adventurous, you can track your way up or down sheep-walks, narrow, rugged, and slippery, while the billows will boom bewilderingly below you, and the sea-birds scream harshly and warningly above you. In yonder little cove, on the other hand, you can lie lazily for hours, sheltered and safe below a natural roof of rock, listening to the pleasant murmur of a quiet sea, watching the labourings and heavings and tackings of sea-ward vessels of all sizes; discovering unthought of caves underneath the cliffs, crawling into them, and winding like a serpent in contortions accordant with those of the passages; and there, in the half darkness, listening to the muffled music of the ocean, and the whistling sound of the winds, and gazing out upon the contracted portions of ocean before you with renewed delight. All this and more you may do in these parts, without fear of bathing machines and bathing people, and troops of children with wooden spades, and lines of giggling school-girls, and trios of town dandies in nautical habiliments; without fear, I say, of any interruption from such customary frequenters of hack watering-places. Still better, if you are not rich, you will not fear a long bill from the "Clarence Hotel," or the "Victoria," or the "Bedford." No, you can breakfast off pilchards (if strong-stomached), dine off pilchards, drink tea off gooseberry leaves called souchong, or chicory called coffee, and sup off good hard cheese and cider, or home-spoiled beer, amongst civil, simple, clean, and obliging people, for some half-dozen shillings a-day, exclusive of shillings to guides and half-pence to the landlady's children!

I wish I could but persuade some of the multitude of fashionable tourists to take a trip or two here! I believe I

should be really benefiting them by my advice. I am patriotic, and a zealous advocate for this home-touring. What unjustifiable folly is it to spend thousands annually upon Gallic cheats and German landlords, to travel in order to feed Neapolitan tyranny, Romish pride, and Tuscan despotism, in order to see sights and scenes not always nor often more interesting than may be witnessed at home! Instead of resorting to Pau and the Pyrenees, try Penzance and the Land's End. Instead of being present at, and thereby countenancing Popish mummeries, and their idolatrous musical services, come down here and listen to the magnificent music of the Atlantic on a starlight night, from a seaward moor or cliff! Instead of inhaling the sickening fumes of Popish incense, come here and inhale the invigorating breezes that sweep with loudly flapping wings over the wide Atlantic! Instead of gazing ignorantly at stiff Madonnas with gingerbread-gilt aureoles, come here and gaze upon Nature's pictures, vast and varied. Leave the frescoes of Michael Angelo, and the quaintness of Giotto, and the stiffness of pre-Raphaelites, (for ten to one if any of you ever *really* enjoy them,) and come and look at the fretted rocks on this granitic coast-range! And as to diet, fling away your *vin ordinaire*, and your Italian wines, and your olive oil, and your *ragouts*, and your soups, and put up with the hard, healthy fare of these wild districts; and then, what with the sharpening sea breezes, the calm, pure thoughts, the grand scenes, the solemn weird moor-stones, the fitful moonlights and starlights, the hours of sea-shore meditation, the sketches you make of striking points, of obelisk-like rocks, and of fishermen's cottages and nets; and what, also, with your familiar intercourse and acquaintance with the persons, lives, trials, and discipline of the simple peasantry;—I say, what with all these, you will be a wiser and better man than if you had seen the Bay of Naples, dived into Pompeii, ascended Vesuvius, mangled the Italian language, kissed the old Pope's hand or toe, and heard the "*miserêre*" in the Sistine Chapel at Rome!

REDRUTH—VIEW FROM CARN BREA.

We have arrived safely at Redruth town, called originally Dedruith, and supposed to be one of the most ancient inhabited spots in the kingdom. It consists of one principal street of considerable length,* and is situated on an eminence in the midst of a wide mining district, and surrounded by a bleak and unsheltered country. On a market-day the town presents a lively appearance, perhaps from the whole being comprised in this one long street. The chief amusement of the Redruthians seem to consist in parading up and down this long street, which doubtless, in their opinion, is equal to Regent-street in a Londoner's. As we entered the town, a horse and cart ran away down this hilly street, dashing furiously through market stalls, and upsetting whole gardens of vegetables, together with crockery, and old women and young children, all of whom (I mean the living beings) miraculously escaped unhurt. Some wise man diverted the horse's course towards the porch of the chief hotel, which we had been about to enter, but we advanced and fixed our abode higher up the street.

Had we been two New Zealanders, we could not have attracted more attention than we did as we subsequently paraded the main street of Redruth. Observations were freely made upon us, some of which were more curious than courteous. Some thought we were Exeter men, some said we were "Luniners," come to buy shares in mines or sell them, and others that we intended to set up as quack doctors, my companion to attend to one branch and I to another.

My readers must now understand that we have arrived at our central quarters for mining expeditions and researches. This town is decidedly the best and most central for excursions to mines of mark and metallic note. Here we are in the heart of the great mining districts of Camborne, Redruth, and Gwen-

* The filthy byplaces are now the haunts of cholera, which has proved sadly destructive.

nap. We have found a nice, clean inn, and discovered it to be very moderate, and the landlady very civil, and a good Methodist. We give her to understand our intention of residing here some few days or weeks, and suitable arrangements are made for us. As to sights in returning home, I leave them to the reader himself, and his guide books; I have taken him to some of the notable and noble scenes. Had we but full leisure, I should have accompanied him to the Lizard Point, with its varied serpentine rocks, and to Kynance Cove, well worth a visit; but as it is, he must visit them without me, if he go at all. And I will only add, in returning home take the opposite coast, and be sure to visit Boscastle and Tintagel, and to remember that the "Cheese Wring," the piece of granite rock resembling accumulated cheeses, is a remarkable natural curiosity.

Arrived and rested at Redruth, the first thing I advise is, the ascent of Carn Brea or Breh, a lofty conspicuous hill, near this town. It may be called the point of view for mines most eligible in the kingdom, probably in the world. As you ascend from Redruth you find yourself gradually surrounded with enormous blocks of granite, which lie all over the hill; and, if you scan them closely and frequently, you observe that they are considerably rounded, and in many instances much worn away. Here you may find hollows in the granite blocks, in all shapes and stages of cavity and capacity; some that would hold a pint, others a quart, and others a gallon. If a geologist, you could not have a finer opportunity of tracing the decomposition of granite, whether arising from divisional planes in the structure, or from concretionary arrangements of the masses. One great block, near the monument to Lord De Dunstanville, is very remarkable for its hollows on the top, scooped out, doubtless, by the beatings of a thousand storms and descending deluges. Indeed, so capacious and regular do these hollows seem, that you would think them to be partly aided by human art; and old Borlase thought the Druids had more than merely a hand in these hollows. Yet a particular examination of the neighbouring stones will lead to the conclusion, that nature did all with her powerful and pelting water-works and tempests; for if the

Druids aided all this work, they must have been as numerous as Scotchmen in England, and as indomitably industrious. In truth, the hill is nearly covered with hollowed granite, and, in one case I saw here, the wearing away of a block had very nearly made a rocking stone, only it seemed to want another thousand years or two to make it as movable as the mass in Treryn Cove.

Now we are at the summit of Carn Brea, no less than 740 feet above the level of the sea. Gaze around—what a scene of desolation! Blocks upon blocks of moor-stone, thick as the beggars in St. Giles's, and as bare and mournful. A forest of mining chimneys rises up high and proudly above the tallest granite, especially towards Camborne. Look steadily beneath the chimneys, and you will see long low heaps, not of granite, but of mining "*deads*," that is, slates and poisonous rubble, thrown up in rude heaps in the course of excavations.

Now, let us go down and ascend that other still higher hill, called Carn Marth, which, at the top stone of the Eastern Barrow, is 757 feet high. This, and another hill which is precisely the same height, are the loftiest spots in the district. Here, too, is the same desolate, stony expanse, marked by mining chimneys, and mining houses, and mining heaps and hillocks. All over this range the farmer seems to play the second part, and the miner the first.

Scarcely in any other district so open and unbuilt on, would you find the agriculturist so completely subdued, and so nearly excluded—moor and mine, granite and chimneys, steam-engines and "*deads*," seem to monopolize the greater portion of the ground from sea to sea.

If we knew nothing of mining and its results—if we did not know really where we stood, but were brought up to these heights as entire strangers, our first inference would be, that we had come into one of the most naturally impoverished and unfruitful parts of Great Britain. What is there to be seen all beneath us and around us, that can make this district worth a day's delay for us, or a day's work for labourers? Few trees, few fields, little that is growing, and little that is green. For

spreading trees, you have forests of huge blocks, for crops you have immense heaps of big stones, for fruits you have only furze and wild-berries. Then, why not leave this unproductive part to solitude and idleness?—Ah! look now underneath this—and then your opinions change. This is one of the very richest portions of England. Right under and round these dead and dreary spots, run marvellous veins of most valuable metal. The veins below are mere threads in size, compared with the blocks of granite above; but those threads are like golden threads in a vast textile fabric.

Those metallic veins of the earth form the sinews of war, and the sinews of British strength—the sinews of commerce, and the sinews of our domestic comfort. More wealth has been, and is to be, extracted from those mines around and beneath you, than from the richest farms, the sweetest pastures, and the fairest fields you have ever beheld in any equal extent of ground in any part of the world. Poverty and desolation and dreariness, indeed! Why, beneath your feet, at the bottom of those hills, are abundant remedies for all of them! If you could but get at, and follow out, the mineral veins in all their capricious starts and wanderings, you would have as much as man could work out, and heart could wish for—and banks could hold.

THE MINING DISTRICT OF GWENNAP.

This includes portions of the parishes of Redruth, Gwennap, Perranworthal, Ked, and Kenwyn. Its rocks are the north-eastern skirt of the great granite range of Stythians, Wendron, &c., and the mass of granite forming Cairn Marth, and Trefula Beacon, and the slate rocks in contact with them. The whole is traversed by numerous elvan-courses, lodes, cross-courses, and fluckans, in cross-veins filled with clay.

This is by far the most extensive as well as the most productive mining district in Cornwall. It is chiefly cupriferous (copper-producing), tin ore being comparatively uncommon.

Much might be said of the numerous cross-courses in this district, and of the mineral composition of the granite, but I proceed at once to speak of the mines.

There have been many very rich mines in this district, now long since abandoned. Of these, Wheal Bassett made a profit of £100,000; Wheal Chance, a profit of £150,000; Wheal Music made a profit to the tune of £100,000; Wheal Spinster obtained a dowery of £80,000; Treskirby, a profit of £200,000; Camborne Vean, of £200,000; and Great Wheal Towan no less than £250,000. These mines were the most profitable, but several others made large sums.*

The great mines in this district are in some cases very celebrated, as the Consolidated copper mines, the Tresavean copper mine, and the United copper mines, which are some of the largest mines in Cornwall. Of these I shall have to speak frequently under different heads, taking them as examples; and their produce and fortune will be noticed as illustrative of mining adventure. Other principal mines are Wheal Jewel copper mine (in Gwennap), which, at the first working, left a profit of £200,000; Poldice and Wheal Unity mines; Trethillan mines of copper; Trevisky and Barrier copper mines; Wheal Busy in Kenwyn, formerly called "Chasewater," and about the oldest copper mine in Cornwall; Creeg Braws mine, supposed to have been extensively worked as far back as the time of the arrival of the Phœnicians in Cornwall, though there are no records dating earlier than 1720; North Down's copper mine, a very old mine, working from 1718 to 1758, making upwards of £100,000 profit—renewed of late years; Hallenbeagle copper mine; West Wheal Jewel tin and copper mine; and Treleigh Consolidated copper mine.

THE CAMBORNE AND ILLOGAN MINING DISTRICT.

This district is comprised within a tract bounded on the east by the valley which divides Illogan from Redruth, on the south

* My authority is Mr. Joseph Yellowly Watson, a well-known mining broker, to whom I am often indebted in these pages.

by the ridges of Carn Brea, Carn Entral, and Camborne Beacon Hill; on the west by a line from Camborne Beacon Hill to about half a mile north of Camborne Church; and on the north by a line parallel to the highway from Camborne to Redruth.

The rocks of this district consist of an elevated range of granite hills on the north, covered on their northern slopes by varieties of slates, and intersected by elvan-courses, and by numerous lodes and cross-courses. The alternations of granite and slate are very remarkable, and this district affords many excellent examples of elvan-courses, or veins of porphyritic rock, occurring in circumstances explained under the head of Mineral Lodes and their Intersections.

The principal lodes of this district have a bearing varying from twenty degrees to forty degrees south of west, and some *dip* (or dive) north and others south; some of the chief lodes dip south, but others in the same mines incline to the north, and have also been very productive.

In one of the lodes at Dolcoath mine, native silver and vitreous silver were found, and a piece of plate was manufactured from it, and presented to the late Lord De Dunstanville. Cobalt and bismuth have been found in Dolcoath and North Roskear.

The principal mines in this district are Carn Brea tin and copper mines, consisting of several mines (in Redruth and Illogan) at the bottom of Carn Brea hill, and being as rich and productive as perhaps any in Cornwall. Many years ago Wheal Fanny, one of these mines, in conjunction with Tincroft, left a profit of several hundred thousand pounds. In one particular portion some rich courses of ore were discovered, and a profit made of £107,500. East Pool copper and tin mine, returned, after an original outlay of £640 by 128 proprietors, ores to the amount of £130,000. Dolcoath copper mine is one of the oldest in Cornwall, having been worked with very little interruption for near a century. It is three hundred fathoms deep, and has left a profit of £600,000. It is a celebrated mine. A beautiful model section of it may be seen in the Mining Museum, Jermyn-street, London. North Roskear copper mine, first opened about

sixty years ago, left a profit of £90,000—the mine was two hundred fathoms deep, and about seven hundred persons were employed. The monthly cost was £2200. The machinery in the mine was valued at £15,000. From June 1834 to June 1842, it returned ores to the value of £213,320.

Cook's Kitchen copper mine in Camborne, is a very old mine, two hundred fathoms deep, and has left a profit of £300,000.

Tincroft tin and copper mine in Redruth, with Wheal Fanny, now belonging to the Carn Brea mine, have produced, at different workings, upwards of £1,300,000. The sett is very extensive. The "dues" levied from one acre of ground were enormous, and there was the richest and largest course of tin ever seen in the county. It recommenced working in 1833.

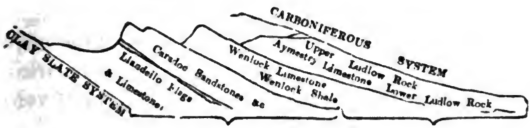
The United Hills copper mine in St. Agnes, has been worked under varying fortunes. It has an eighty inch cylinder steam-engine, and ten years ago employed about four hundred persons. In Wheal Curtis tin and copper mine, a profit of £130,000 was once made. In 1836, Captain Teague carried it on upon his own account, and in 1840 had expended £15,000 on the works, and returned ores to the value of £5110. Trenoweth copper mine in Crowan, is on the same range of lodes as Wheal Abraham, Crenver, and Oatfield mines, which, from time to time, have left profits of upwards of £150,000. This mine was worked some years ago by a party who expended some £20,000 in only extending the adit level, and sinking several shafts on the main line of lodes. For reasons not easy of explanation, the mine was abandoned in 1822, but it has been of late resumed.

GEOLOGY OF CORNWALL: GRANITE, CLAY-SLATE, CHINA CLAY.

Wishing to present at one view the general succession of the earlier British strata for popular information, I subjoin two diagrams; the first of which represents granite, and the rocks immediately succeeding it. Granite is found almost universally beneath gneiss and mica schist, sometimes touching one, some-

times the other. It generally appears to have been in a state of fusion since the deposition of these superincumbent strata, for veins of it are injected into their cracks and fissures.

The next diagram illustrates the strata from the clay-slate to the carboniferous system.



In this volume (and one that may follow), I have only to notice granite, clay-slate, and the carboniferous system; the two former containing the mineral deposits of Cornwall, and the last, the mineral deposits, as lead, coal, and iron, of Derbyshire and the north of England.

In Cornwall the slate formation rests on the granite, at an angle which, on the whole, varies but little from 45°. The formations intervening in other districts between granite and slate, seem in Cornwall to be mostly wanting. The proportions of the various constituents of the slate rocks perpetually vary, even while their other general relations remain the same. The prevailing components are felspar, schorl, hornblende, chlorite, and mica. The local term *killas* is applied to every member of the slate series. The two hills, Carn Brea and Carn Marth, are outstanding portions of a larger district, a comparatively slender covering of slate converting them into insular patches.

Granite rock lies at the foundation of our scale of rocks, and is of igneous origin. It is a compound, granular, aggregated rock, composed of minerals termed felspar, quartz, and mica, mostly in distinct crystals. Sometimes the one, sometimes the

other of these ingredients predominates, but most generally the felspar, which is also the most distinctly crystallized of the three. Granite varies, in respect of its granular character, from the very large to the very small; the larger-grained kind probably belonging to the oldest formations, and the small fine-grained to the newer formations. It is vulgarly thought that all granite is alike; but this is far from being the case. Aberdeen granite is unlike the Cornish, and the Cornish itself is not all alike. That of the two hills we have just described, is unlike even that of the Land's End; the former contains little of a dark mineral called *schorl*, and the latter contains much of it. Schorl may be observed between and approaching the joints of granite in many places, as, for example, near the Logan stone. Go on to the Scilly Islands, and you find granite of a somewhat coarse compound of quartz, felspar, and mica, both dark-coloured and silvery; and also a finer granite in the form of veins.

Taking Cornwall altogether, there are six principal masses of granite (including that of the Scilly Islands) occurring in the county, while smaller patches are found in several localities, as St. Michael's Mount, Carn Brea, and Carn Marth, all of which we have seen. The range of the principal masses of this rock (including Dartmoor and the Scilly Islands) is about twenty-four degrees north, and twenty-four degrees south.

When we were in the coal-fields of the north of England, we were amongst stratified rocks—rocks deposited from aqueous solution, and, therefore, lying in distinct and defined beds. In the earlier portion of "Our Coal Fields" (pp. 41-57), I inserted enough geology to lead to the comprehension of the position of coal in the series of British rocks. But we are now below all these secondary and stratified formations, and deep amongst the masses that bear up the earth's huge pillars.

Granite, like all the primitive rocks, is unstratified—that is, there are no beds or strata in it, or it is not composed of them. It is, most probably, the produce of fire and internal heat, being fused and boiled up, as it were, into masses, that have had all their inequalities melted down into uniform structures. Yet, in Cornwall, you do find a structural form prevail in the

large masses which gives them a stratiform appearance, and has deceived some early observers into the belief that granite was really stratified. But, though often continuous for long distances, this stratiform division is wholly deceptive, and mostly extremely imperfect. The whole appears like the base of a stone rubble wall without mortar. This laminated structure renders the granite certainly more easily divisible in its direction. But, in addition to this, there are more or less perpendicular joints, or divisional planes, which, meeting with the horizontal laminated structure, tend to divide the granite rocks into cubical or rectangular blocks. I have already noticed how this might lead you, at and near the Land's End, to think you were looking upon basaltic pillars, whereas you are truly gazing on granite. Scarcely any where can you see such massive quadrangular columns of granite as in Cornwall, and more particularly at the Land's End. This kind of divisibility may, too, have led to the readier separation of granite rocks into "tors" and pillars, and most probably the rocking-stone at Trereen has been formed by the forces of wind, storms, and rain, working in the line of these cleavages.

Although granite is one of the very hardest rocks, yet, singular as it may seem, there is such a thing as *soft* natural granite. That rock which is the poetical type of hardness, and the practical example of it under our feet in the most frequented London streets—yes, this very rock is found soft, and soft, too, in parts of Cornwall. Such softness arises from a decomposition of the rock, more particularly of the felspar in it, which gradually pulverizes it to a "soft growan," as the Cornish say; and such decomposing granite is found at St. Stephen's, St. Austell (Carclaze tin mine), Roche, and Breague. This change appears very striking where you find hard mineral veins (as at St. Austell Hill mines), or the contents of joints of crystalline rock, adjoining (as in Carclaze tin mine) and standing out in relief from amidst the decomposed granite in which they were once included. It is probable that the lodes and substances actually between the joints have been fissures, when the granite was solid on both sides of them.

From this decomposing granite is manufactured that useful article known as china clay. This substance is prepared artificially in Cornwall and Devon, chiefly from Hensborough or St. Austell granite. The process is very simple, and consists in washing the decomposed rock in such a manner, that, by the aid of a succession of tanks, the heavier and useless particles of quartz, schorl, or mica, may fall from the water in which they were held mechanically suspended, or forced forward by its velocity—while the fine particles, those composed of the remains of the decomposed felspar, are carried onward, and allowed to settle quietly in other tanks. The water being removed from these, and the sediment partially dried, it is conveyed to proper houses, where the drying is completed. In a district of decomposed granite, such as much of the eastern part of the Austell mass of that rock, those places are selected in which the rock contains as little hard matter as possible, and where water can be turned on conveniently. By a succession of falls and catchpits, the clay can often be obtained so as to be cut into cubical masses of about nine inches or one foot sides; these are carried to a building through which the air can freely pass, and where the lumps can be completely dried for the market. A more detailed description does not fall within the plan of this book.

This is an important article of commerce. In 1812, no less than 1252 tons of it were exported from Charleston to the Potteries. Between 25th March 1816, and the same day in 1817, there were shipped from same part 1775 tons of this article for the Worcestershire china manufactories. The exportation has largely increased of late years. I subjoin the best information I can obtain on this article of commerce.

In 1838, there were exported from Cornwall 20,784 tons of *china clay*, and 7344 tons of *china stone*, which latter is a talcose granite, in which the decomposition has proceeded no farther than to render the whole mass friable. Only one part of the felspar is changed into clay. It is carefully selected so as to be free from schorl, and requires only to be broken into a size convenient for carriage to market.

THE AVERAGE ANNUAL EXPORT FROM PARTICULAR PLACES IN CORNWALL IS AS FOLLOWS:—

CORNISH CHINA CLAY.	AVERAGE EXPORT.
	TONS.
From Charleston	40,000
„ Par	10,000
„ Pentewan	18,000
„ Other Harbours	12,000
Totals Exported	80,000

To show the importance of this article, I add another table, which will give the value in relation to Staffordshire:—

VALUE OF CHINA CLAY MADE AND EXPORTED IN SEVERAL YEARS.	VALUE.
	£
Exported from Stafford in 1835	280,000
Ditto Ditto 1837	560,000
Ditto Ditto 1841	600,759
Ditto Ditto 1851	1,210,000
Exported from Stafford, Derby, Worcester, & other Potteries } 1852	2,150,000

The drying of this china clay by the natural process, after its preparation, often requires six or eight months. But a machine has recently been invented which greatly accelerates the drying. The machine resembles a clothes-horse, such a one as is commonly used for drying clothes after washing. The lumps of china clay are placed in the compartments of the drying machine, and the whole is then rotated with great velocity. Thus the water is thrown off by the operation of the centrifugal force, and two tons of clay can be dried in five minutes. The same principle has been introduced in the drying of manufactured sugar.

It is reckoned that more than £200,000 is annually spent in Cornwall in obtaining and preparing the china clay.

So remarkable a contrast between the extreme hardness and softness of the same primitive rock, is well worth notice and reflection. Think only of this curiosity of geology:—A rock is primevally fused and cooled into as hard a substance as nature affords; so hard that it paves our streets in long-enduring slabs and blocks. Tens of thousands of feet passing daily over it, make no impression upon it. Years of travel only see it smooth and shining. The men who pass over it pass away, but it is still durable and unsoftened. Halls and mansions, clubs and palaces, are built of it, and it endures unmarked by Time's devouring tooth. Is it not adamantine?——But, lo!—what is that elegant cup from which you are sipping your tea? It is of Worcestershire china, fine, and almost pellucid. Well, it is made out of the soft ruins of that very granite whose endurance is typical and proverbial! Wondrous transition! We have been walking through, and talking about, and gazing upon blocks of primeval antiquity, of countless years, and in wild profusion scattered over hill and plain. Ten thousand years have only scooped one hollow in that big mass of rock; and yet here is a simple tea-cup, and tea-service, which could not have been what you now see, but for granite tender, and crumbling, and clayey, and made so by the very hand of nature, which has upreared and scattered those innumerable pillars, more durable than brass, which we have been describing.

How remarkable that the best types of firmness and fragility should be found in the same stone! What the immense billows of the Atlantic are now beating upon, at the Land's End, without effect—that very same substance has been found in such a friable natural condition, as to be finally moulded into that vase, which stands elegant and admired upon your mantelpiece; and which one puff of wind, or one whirl of a lady's silk dress, would dash down into innumerable and unmendable fragments! Let no man after this consider granite as a barren subject.

The Carn Menelez mass has chiefly furnished the granite most commonly known as *Cornish*. It is nearly entirely shipped at

Penryn, to which place it is brought various distances from different quarries in the vicinity. Being obtained from different localities, it will be readily supposed that the quality of this stone is very variable. Penryn granite is often specified in contracts for buildings and public works, and is divided into first and second grits. It is to be feared that seconds have sometimes been mistaken for firsts—whence "Cornish granite" has been sometimes unfairly maligned. When we rowed up in a boat to Penryn quay, we could have thought we were about to land on a Cornish moor, seeing the multitude of blocks that stood ready for shipping. The "best blue fine granite, or grit-ashlar, for building sea-walls," fetched 2*s.* 2*d.* per cubic foot, scabled; and the second blue grit, ditto, 2*s.* This is an important trade in the district, and in past times there had been about four hundred men employed in quarrying the granite near Penryn, with wages varying from 12*s.* to 15*s.* per week each man. The following are the exports of granite from Penryn:—

YEAR.			TONS.
In 1824 they amounted to			10,178
1825	do.	do.	10,781
1826	do.	do.	18,179
1835	do.	do.	8,310
1836	do.	do.	11,538
1837	do.	do.	5,295

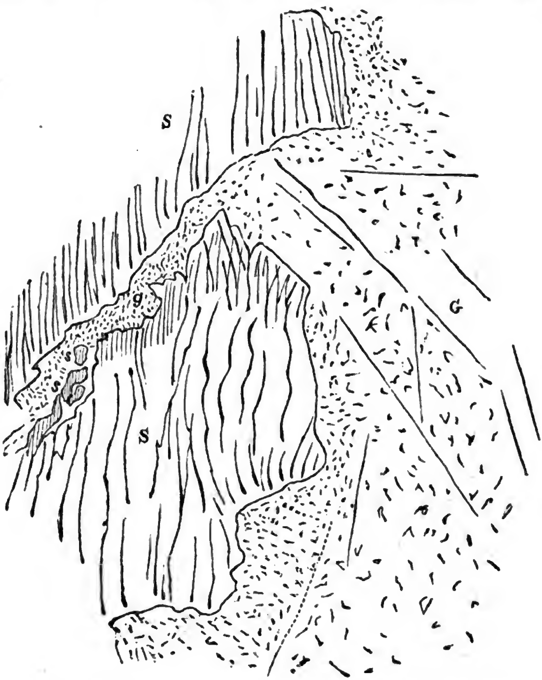
In 1852–3, the granite exported from all parts of Cornwall exceeded 30,000 tons.

Consolidated sands form a curious but desirable building material in some parts of Cornwall. Crantock church is built of it, where it hardens by exposure, and ancient stone coffins are formed of the same material.

GRANITE VEINS IN CLAY-SLATES, ELVANS, &c.

Granite veins are very curious geological phenomena, and no part of the world equals Cornwall in the abundance of opportu-

nities offered by its sea-cliffs, streams, and mines, for studying the veins, which at almost every point branch off from the subjacent masses of granite into the " Killas," every where incumbent upon them. *Killas* is a local term for clay-slate, and seems to be applied indefinitely to any one of the beds of the slate formation, and the word *elvan* is another local term for granitic or porphyritic rocks. The term is often used loosely, and often contradictorily, but the rock possesses the same constituents as granite, and cuts the slate and granite, occasionally traversing both in one continuous body of rock, somewhat in the manner of trap dykes. Elvan commonly constitutes great



S The slaty rock. *G* The mass of granite.
g One of the veins. The style of dotting is intended to represent the fineness or coarseness of grain in the granitic mass and vein.
s Portion of slate included in the granite vein.

lates of granite, or porphyritic matter, filling a previously xisting fissure; generally there is a slight coherence between he walls of the containing rock and the elvan. The granitic ein piercing the rock above it, and ramifying in all direcions, may be made tolerably conceivable to the reader by a iagram of an actual case, as shown in the previous page.

Some plans might be given where the granite veins ramify n almost every direction; and are of almost every size and orm—plain or indescribably twisted, of large or small grain, ure, or holding fragments of the neighbouring killas, or mixed ith greenstone, crossed by quartz and schorl veins, and by netallic lodes, which displace the veins of granite and quartz—ariously connected with serpentine masses and veins of steatite.

The killas, too, is of most indefinite composition. The granite ncludes contemporaneous veins; and the same district is perlaps broken into innumerable parts by metallic lodes, elvan ourses, and other accompaniments of subterranean dislocations.

St. Michael's Mount is as interesting geologically as historially, and it is the solitary prominence of granite in that district. That part of its base which lies towards Marazion is of slate, vhilst its summit and southern side are of granite. The juncion of the two rocks is well shown on the beach, where also are een the granite veins by which the slate is traversed. They nay be readily reached and observed at low tide, and are seen o proceed from the main mass of the granite, and to include letached portions of the slate, into which they penetrate. At he same time, the main mass of the granite, the slate, and the granite veins, were cut by veins of quartz, mica, &c.

Some years since a hot controversy (as hot as the granite veins must once have been) was carried on, amongst geologists, n the subject of the relative antiquity of the veins to the slate n which they were found.

Without a diagram and a geological taste in the reader, I can lo nothing to elucidate the subject at that spot. I only say, magine a piece of ice shattered and cracked in all directions, nd the water nearly dividing one portion, and then you get ome icy notion of the contact of the slate and granite at the

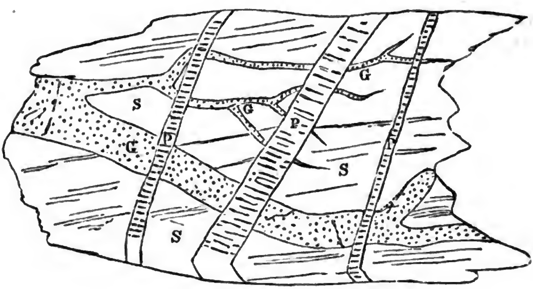
spot on the north-east side of the Mount. I imagine that th granite veins were injected into the cracks of the slate when th granite was protruded through it; and that subsequently, afte an alteration of the original character of the slate adjoining th granite—in consequence of the new conditions to which its par ticles were then exposed—joints or divisional planes wer formed through the whole mass, as has been a very common cas throughout Cornwall and Devon under similar circumstances Probably the partings of these joints were afterwards filled u by different mineral substances.

Doubtless the granite was once as "boiling hot" as melte lead, and, in a state of igneous fluidity, was projected upward by immense force below.

Fine exhibitions of granite veins traversing slate, are seen al around the Land's End mass of granite, also at Cape Cornwall Whitsand Cove, Wicca Pool, and numerous other places.

The adjoining figure shows a case of granite veins, G, dividin a schist rock, S, and filling ramified fissures, which are them selves crossed and cut through by straight dykes of porphyry, P

The porphyritic masses above alluded to as elvans, var from a few feet to 300 or 400 feet in breadth. Thoug



comparatively narrow, many can be satisfactorily traced for several miles. One of the longest runs from near Marazion for twelve miles, sending off a branch near Cayle about five miles long. It is evident that those elvans which traverse the granite

and slate rocks, are of an age posterior to the consolidation of that portion of the granite which they cut through.

The time of the formation of those which only traverse the slate, is not so clear. Some may have been formed at the epoch of the intrusion of the great masses, while others may even have been produced after the elvans which traverse the granite and slate. As to their composition, the elvans have mostly a common mineral character, though of very variable degrees of induration.

These curious rock veins are very useful in enabling us, when we trace and map them, to establish a connection between the principal masses and patches of granite in Cornwall and Devon. They may be considered as mere granitic dykes, the chemical composition of which bears a close analogy to that of the chief granite masses in the vicinity of which they occur. They would appear to occur somewhat in groups. A chief group occurs between Truro and Mount's Bay, including the elvans of Gwennap, Redruth, Camborne, &c., St. Hilary, and Marazion.

Sometimes the elvans cut off valuable lodes of metal, while, in others, they themselves contain metal. The great elvan rising north of the valley leading into Unity Wood, in Gwennap, has been extensively worked for tin ore, which is abundantly sprinkled through it. A ground plan of the lodes of Polgooth tin mine, shows a curious instance of an elvan having been cut and displaced at the point of intersection with a lode (St. Martyn's lode), which is also cut and displaced at the point of intersection; while between them both runs a cross vein of clayey matter, called "flucan." Such curious interruptions occasion the greatest perplexity in following lodes. It is singular that in this instance the same elvan runs through another lode (Screed's lode) in the same mine, breaking and displacing the lode, but the elvan itself continues its course unbroken. The flucan thus intersecting the elvan course and St. Martyn's lode, occasions a leap of 114 feet upwards to the smaller angle.

The primary rocks have received very much attention from geologists, chiefly in relation to their supposed relative ages. The slate-system has obtained its full share of such attention, but this is not the book for such matter, although the locality

suggests many reflections; for, with the exception of the igneous rocks as above noticed, almost all Cornwall and Devon (south of a line from Tintagel by Launceston to Exeter) is composed of clay-slate and slaty rocks. It seems that the slates of Cornwall and Devon are nearly of the same geological age as those of North Wales and Cumberland; but the metalliferous ores found in them differ exceedingly, tin abounding in the southern counties, and copper being the staple in the central and some part of the northern, and lead in other parts of the northern district. It is true that copper and lead ore are found with tin in Cornwall, and lead is associated with the copper of North Wales and Coniston water head, but there are indications of preference.

Having now treated of the rocks so far as relates to the mining districts of Cornwall, I may advance to the consideration of the minerals deposited in or near those rocks. The reader will now be prepared for a somewhat scientific account of such mineral deposits. I shall give him, in as plain language as possible, the result of much patient investigation into a subject which literally does not lie upon the surface.

MINERAL DEPOSITS.

Of the various classes into which mineral deposits may be divided, it will be sufficient for our present purpose to notice the four following:—*Veins* or *lodes*, *beds*, *masses*, and *fragmentary deposits*, each of which is the repository of vast mineral treasures, but more especially the veins and beds. Of veins or lodes I shall speak last, because they form the principal subject of the mining treated of in this volume, and require detail.

Beds may be defined as layers of mineral substances, interposed between the strata of solid rocks, which, except in their containing mineral matter, they very much resemble. The layers of flint which may be seen imbedded in chalk, wherever a section of the cretaceous rock is visible, as at Brighton, Gravesend, Dover, &c., will convey a good idea of a mineral bed. Several of the metals, as lead, are occasionally found in beds; coal, clay-ironstone, and rock-salt are only found in beds. When

minerals are found in beds, the mining works for extracting them are not elaborate or interesting, since they partake more of the nature of large open pits and plain excavations, than of the complicated arrangements of such a mine as a large copper or tin mine. For this and other reasons the mining of iron has not been treated of in this volume. It will be obvious that no mining skill or science is necessary to the extraction of a huge mass of clay-ironstone. Moreover, as coal and iron are often mined together, as in Staffordshire, &c., what I have said of the extraction of coal in my previous volume will apply, in a great measure, to that of iron.

Masses are sometimes termed *pipe-veins* by miners, and of such I have to speak under lead-mining. The best conception that can be formed of them is, that of an irregular branching cavity, descending either vertically or obliquely into the rock, and filled up with metalliferous matter. Deposits of this nature are not very common, and they usually contain either copper or lead. Some of the rich oxides of iron appear to belong to a similar formation.

Fragmentary Deposits occur associated with, and forming part of many of the loose superficial beds of sand and gravel which occur in the valleys of mineral districts, consisting of the detritus of neighbouring mountains which has been washed down from thence at remote geological epochs. The mineral substances found in those deposits (which may be viewed as having been originally derived from veins or beds in the vicinity), are not, in most cases, mixed up indiscriminately with the alluvial matter, their greater specific gravity having occasioned them to be deposited in distinct layers by themselves, usually towards the bottom of the mass. Gold and tin are the metals which most commonly occur in deposits of this kind. These tin deposits are treated of in noticing stream tin works, in another part of this volume. There are several such in Cornwall, especially near St. Austell.*

The great gold diggings of Australia appear to consist of

* Tin has recently been discovered in alluvial matter in Australia. It is abundant, and of good quality.

particles and masses of gold (nuggets), distributed much in the manner of fragmentary deposits.

NATURAL STATE OF METALLIC ORES.

Misconceptions on this head are very prevalent amongst general readers. The great bulk of the metallic ores, when in their natural situations, constitute a most heterogeneous mixture, in which the really valuable metal exists only in a small proportion, chemically combined with one or more mineralizing substances, and entirely intermixed with sparry and earthy matter, and ores of inferior metals. The great amount of metals (excepting gold, and some rarer masses of native copper and meteoric iron) are found in this state of *ores*—*i. e.*, chemically combined with certain mineralizing substances, which completely disguise the metal; and so much is this the case, that many, if not most persons, would pass over and reject specimens from some of the most valuable mines. A stranger taking into his hands good specimens from the Cornish mines, would often require to be distinctly informed that such specimens are rich in the particular ore. Any one may satisfy himself of this fact by inspecting, in our museums, specimens of certain tin and copper ores in the rough.

The most important of the mineralizing substances are oxygen and sulphur. The next in rank are chlorine, and the sulphuric, carbonic, and phosphoric acids. The mode in which they combine with the metals is, chemically speaking, either in binary compounds, or in the union of two pairs of such compounds. Of the former, we have examples in iron, lead, and mercury, which, when mineralized by sulphur, form respectively the following sulphurets, iron pyrites, galena, and cinnabar. The latter we observe in all cases where the metals are mineralized by acids, as in spathose iron ore, or carbonate of iron, in which one binary compound, the oxide of iron, is united to another, the carbonic acid.

Thus, in the separation of metals from their foreign accompaniments, we have two classes of admixtures to remove—one,

the *chemical combination*, or mineralizing substance just spoken of, and the other the *earthy impurities* mentioned antecedently.

The stone, or mass of foreign matter in which the metallic ore is found, is termed the *veinstone* (or matrix), and the nature of veinstones has been carefully studied, as affording some kind of index to the position and probable prospects of metals in veins or lodes. Thus, miners always notice and sometimes record the veinstones of copper, tin, &c., attaching much importance to them.

In describing the metallic lodes presently, I shall mention that large masses of ore are often accumulated in *bunches*, confined to particular portions of the lode; but there is also a great proportion of the ores which, in all mines, is more or less intermingled with the veinstone, and frequently finely disseminated through it. As the expense of fusing this large mass of earthy matter would greatly exceed the value of the metals which it contains, great skill has been shewn in mining countries, in contriving mechanical processes for effecting its separation as soon as extracted from the mine. When this separation has been properly accomplished, the metallic residue can be profitably smelted, to the benefit of the adventurers and the labouring classes who " dress" the ores at the surface of the mining grounds. The average yield, in Cornwall, of pure copper, is from six to eight per cent. of the whole mass of ore.

Under the head of each metal (tin and copper), I shall describe the dressing-processes appropriate to each, as adopted in the counties where the metals are mined.

The principal mineral districts in Cornwall, and indeed in our whole country, as well as several other mining countries, have been explored and pretty well known for many years; and by far the greater part of our mineral produce is extracted from deposits which have been long worked, the principal new discoveries being made upon untried *portions* of known veins; or otherwise simply by cutting passages or " cross-cuts" from mines now working, in a direction transverse to that of the vein upon which they are wrought, so as to prove the adjoining ground.

It is chiefly by the knowledge of the geology of Cornwall, as far as relates to its oldest rocks, as granite and clay-slate, that

the miner has ascertained the situation of the veins of minerals. Experienced miners become acquainted with the particular kinds of granite, or elvan, or clay-slate, which are most favourable or "kindly" for veins. A distinctly crystalline structure of granite, and a slaty texture, and a high inclination in the slate, are considered discouraging; while, on the other hand, a soft structure both in granite and slate, and, in the latter, a moderate thickness in the beds, and a slight inclination of the laminæ, are viewed as encouraging features. It is to granite, "elvan" (a porphyritic rock), and killas (clay-slate), and especially the junction of granite and killas, that we must look for the situation of mineral veins or "lodes," which terms are synonymous—the term "lode" being mostly confined to Cornwall.

The lead veins of England lie chiefly in the mountain or carboniferous limestone, under somewhat different natural conditions: these I shall reserve for notice in the pages of a future volume.

THE MINERAL VEINS OR LODES IN CORNWALL.

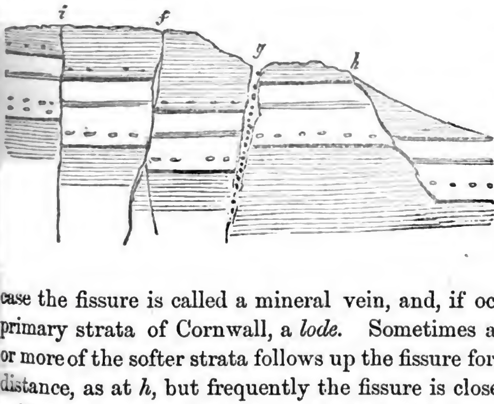
Most metallic minerals are found in veins or fissures of rock, and veins (which will be fully treated,) are cracks or fissures in the rock, seldom occurring in a straight line, yet maintaining a general direction, though in a zigzag form, striking downwards at a very high angle, seldom deviating from the perpendicular so much as forty-five degrees, and extending to an unknown depth. When they pass through stratified rocks, they are further often accompanied by a subsidence of the beds on one side of their course, and by an elevation on the other. The "throw," or perpendicular distance between the corresponding strata on the opposites of a vein, varies from a few inches to thirty or forty, or even a hundred fathoms.*

A vein (like some men's speeches) has scarcely any known beginning or end. When explored, they are found to commence abruptly, and, after continuing active to greater or less distances, they branch off into smaller veins or "strings."

* A fathom is the common measure in mining, and is equal to six feet.

The nature of faults, dykes, and slips, have been sufficiently explained and illustrated in "Our Coal and Our Coal Pits," (pp. 48 to 57.) Now it has been commonly noticed that mineral veins do not otherwise differ from faults, than by reason of the fissures which these have opened in the rocks being filled by sparry and metallic matters. A fissure filled by basaltic or other rocks, would be called a rock *dyke;* if occupied by clay and soft materials, a clay dyke.

The following diagram will enable us to understand the different kinds of fissures. In some instances, as at *f*, the fault-fissures are open; in others, as at *g*, full of angular fragments of the adjoining rocks, or of metallic minerals, in which last



case the fissure is called a mineral vein, and, if occurring in the primary strata of Cornwall, a *lode.* Sometimes a *leader* of one or more of the softer strata follows up the fissure for a considerable distance, as at *h*, but frequently the fissure is closed, as at *i*.

In one sense it might be said that the whole art and mystery of mining consists in a knowledge of the courses, characters, conditions, and apparent caprices of mineral lodes. They form, as it were, the narrow strip of pith in the whole bulk of wood in the tree. Or, I may say, that they run through the dark, dull rocks in glittering streams, like the long, narrow rivers, traversing the broad earth with their shining waters.

Lode is the Cornish term for a mineral vein. Lodes may be briefly described* as venous portions of the rock, highly inclined, of no great thickness (in which respect they are very variable),

* I here adopt chiefly the language of Mr. Henwood, an admitted practical authority.

and more or less mixed with metals and their ores. They have commonly one prevailing direction, subject to slight irregularities and curvatures, as well in length as in depth. They traverse granite, slate, and the "elvans" indiscriminately, and almost always without other interruptions than what may take place from their interferences with each other, and with the foreign interruptions locally called "cross-courses," "flucans," and "slides."

Lodes invariably throw off, into the containing rock, "shoots," "strings," and "branches," often in such abundance, that instead of one main lode, called a "champion lode," the whole is an irregular network of veins. It is not at all certain that the same lode has ever been traced for more than a mile in length. Very often the lode first discovered dwindles to a mere line, whilst some of its offshoots swell out, enlarge, and rival, or even surpass, both in size and richness, the vein from which they have separated. The lodes more commonly split as they go eastward than the contrary.

It is by no means uncommon for lodes to split directly at the point of their intersection by a cross-course or flucan (a course of clayey rubbish), on one side of which the lode appears in two branches, while on the opposite but one occurs. The veins which separate in this way, sometimes reunite both horizontally and vertically, and hence masses of contiguous rocks, provincially called *horses of ground*, are on all sides surrounded by veins. Such masses are met with in almost every mine. When a lode divides into branches, the miners say it has *taken horse*, and this they generally consider a favourable sign; for there are commonly, as they affirm, some rich *bunches* of ore at the *tail of the horse.*

In endeavouring further to present, in a compendious form, the results of numerous investigations into lodes by the most experienced observers, I shall arrange the observations under different heads, in an order which will be readily understood upon a little reflection.

I.—THE PARTICULAR CHARACTER OF THE LODES.

This character may be considered under the heads of Structure and Composition.

A.—*Structure.*—The mechanical structure of lodes, like that of the rocks, seems to be in some measure dependent upon their mineral characters.* When most uniform, they consist largely of the rock or mineral called quartz, and then a pointed structure frequently prevails; but a more mixed and heterogeneous composition is most prevalent. The quartzose parts of lodes are often traversed by joints, having the same direction as the lodes themselves, which are then divided lengthwise into other sub-veins or plates, termed in some places *combs.* But these joints do not long continue distinct and separate; for they curve, unite, separate, and again fall together, and thus divide the substance of the lodes into irregular plates. This varied structure seldom extends through more than a few feet or fathoms, either in length or depth.

When the portions which are more particularly metalliferous (rich in metal) in the lodes, are contained between two nearly parallel joints, they then appear to have smooth *walls;* but these walls do not always indicate a sudden and strongly marked distinction through the lodes and the adjacent rock (locally, country). Near the separation between the lodes and the rock (country), the joints are frequently filled with an unctuous clay (flucan). Polished and striated surfaces, consisting usually of copper and pyrites, often cover the face of the walls of lodes, and are technically called *slickensides*—a foreign mining term with which fabulous properties have been associated; for it was said that, upon slickensides being struck with a pick or hammer, the whole

* It must be remembered that it rarely happens that lodes can be seen at all by the light of day. The study of them is truly a study by candle-light. Exceptions, where lodes can be partly observed in daylight, have been found at Drake's Wall mine, south of Gunnislake, and at the Charleston mine, near St. Austell, where the upper part of the great tin lode is open to daylight for several fathoms. Drake's Hall mine, however, is the better example, and is acccessible on the high-road from Tavistock to Callington.

mass exploded with a loud report, shattering every thing near it. Fine specimens of slickensides are preserved in the Government Geological Museum, in Jermyn Street, London.

A minute inspection of the "comby lodes," as those which exhibit much of the comb-like structures are called, is very useful in enabling us to form some reasonable conjectures respecting the mode in which the contents may have been deposited in them. Sections of comby portions of several lodes present an appearance like that of the lengthwise sections of the honey-comb; and even like the arrangement of seeds in the melon and some other fruits. In one specimen all the combs or plates have the points of the crystallized substances of which they are composed (viz., quartz, purple fluor spar, and sprigs of yellow copper), turned inwards, and all are readily separable from each other by a moderate blow along the surface, which separates the combs. Hence we should conclude that the breadths of each comb constituted the whole width of the fissure, at the time the substances of which the comb is composed were crystallized upon both walls of the fissure as bases, so that the crystallization gradually met in the centre; and, if this be correct, we should have six consecutive openings of the fissure for the contents of the above lode. Other specimens show varying structure of this kind—and the most patient study of such specimens is necessary to any theory of the formation of lodes.

A lode which abounds in "drusy" cavities, allowing the water to pass through them, and thus draining the mine for a considerable distance, particularly when the water is very warm, is thought well of as to productiveness. A London speculator having heard that, in one of the lodes of the United mines, water had been arrived at which was nearly boiling *hot*, immediately bought twenty shares, and has proved a fortunate speculator. It is also thought a good sign if the lode be soft, and also if the contiguous rock be very soft; but if the lode itself be soft, and the contiguous rock hard, little must be expected, for then the lode usually dwindles or splits into several small strings.

B.—*Composition and Contents.*—In directing our attention to the contents and composition of the mineral veins of Cornwall

and Devon, we see the general resemblance they bear, more particularly in the slate districts, to that observable in common fissures and faults. In some the layers are parallel to the sides of the including fissure; in others, the irregularly mixed substances, and the cavities of various sizes (usually lined with some crystalline mineral), at once recall to our attention the contents of fissures and faults not containing metal. Add to the above feature, the contained fragments of the adjoining rocks cemented together, and then the general resemblance becomes very striking and clear.

Even the most regular tin and copper lodes are very complex in their composition. Quartz generally prevails in the matrix (mother stone), but is always more or less blended with a substance similar to the adjoining rock. Indeed, the latter often occurs in distinct forms, as in nodules or angular pieces; and even masses of considerable size, which are independent of the main rock, being completely enveloped in the quartzose part of the lode. These are of such common occurrence, as to have been named *horses of killas* (clay-slate). Sometimes the schist so abounds in the lode, that the quartzose part disappears altogether, or is only continued in minute strings. In such a case, the lode is said to have dwindled away, or to have *wrung out*. It also frequently happens that both these principal parts (the rock and the quartz) are intimately united, producing a siliceous layer of rock, which still bears metal, and is commonly called *capel*.

In Relistian mine, slate and quartz pebbles, cemented by oxide of tin and bisulphuret of copper, occurred (says Mr. Carne) at a depth of 600 feet below the surface in the tin lode, the mass being about 12 feet in length, and as many in width and thickness; scattered pebbles being found in the vein far beyond these boundaries. In another lode, pebbles of granite were mixed with pebbles of slate and quartz. It is very common to find in lodes small angular fragments of the adjoining rocks, cemented by different substances, metallic or otherwise. Fragments of slate cemented by quartz and yellow copper were found in the principal lode at the Consols mines, Gwennap, and angular portions of slate, cemented by yellow copper, occurred at

the United mines, Gwennap. These are only some examples out of many of the same kind. In the Consols mine, in Gwennap, a certain mining captain observed, in 1830–2, at the back of the 135 fathoms level at Frances' shaft, that for more than 25 fathoms in length, and 15 fathoms in height, the lode was from 8 to 12 feet wide, and full of fragments of slate and copper, some of the fragments of slate weighing several tons, and occurring, as to the position of their laminæ, in all directions. Many of these masses and smaller stones appeared to have been washed by a flow of water. Above this mixed mass, and in the level above, a great cavity (called by miners a *vugh*) was found, of many fathoms in length and height, from whence it was conjectured that the fragments beneath had fallen. About 1600 tons of copper ore were found in this curious deposit.

From several observations it appears that fragments of the adjoining rocks in the body of the lode are more frequently seen when the dip of the fissure is somewhat inclined, than when the fissure approaches a vertical position; and it would also appear that the fragments in a given lode were not introduced into it all at one time.

Near the surface the lodes are often full of hollows, and contain a varying earthy brown iron ore, called by miners *gossan*. Gossans themselves have in many parts, from time immemorial, been worked for tin ores. They also frequently yield earthy black copper ore. Gossan* becomes an important feature in the contents of a lode, from the observations made respecting its accompaniments; and in speaking of this peculiar iron-ochreous substance, I come to describe more particularly the metallic portion of the lodes. For convenience, the miscellaneous contents I have just described as found in the lodes, are called the *mechanical* contents, and the other and important portions the *metalliferous* (and sometimes the *chemical*) contents.

As regards the metalliferous (metal-bearing) part, very

* While writing this, I read that on December 17th a considerable business was done in the mining market in London, in the non-dividend paying mines, where the *gossans* were thought to contain *gold*. The question is now being considered, if auriferous gossans can be made to pay for the extraction of the gold in them. Much controversy exists on the subject.

erroneous impressions have prevailed away from the mining districts, as to the mode of their occurrence in the lode. Instead of forming lines of metal running throughout the whole extent of the vein, they occur in what the miners term *bunches*, or in patches of various sizes and shapes. These very rarely occupy the whole space between the walls (containing sides) of the lode, even when these latter are rich and of tolerable width; but they are mixed up with a variety of other substances, the principal part of which is quartz. It will be at once understood, that the proportion which the bunches of ore bear to the unprofitable parts of a vein, is by no means so great as might be at first supposed. We may say that if a fair tabular view of the Cornish and Devon mines were prepared, excluding those which have merely been worked to deceive unwary adventurers, and only including those which have once been profitable mines, though now valueless, then a very different estimate would prevail of the proportion which the ores of the useful metals bear to the profitless parts of mineral veins.

As the discovery of *bunches* is of so much importance, miners have studied how to ascertain those circumstances which ordinarily accompany the lodes in which the bunches are found; so that, when they are in search of the metalliferous portions of the lode, both time and money may be wisely and successfully directed. A great variety of facts have, in consequence, been observed, and it is only to be regretted that they have not been systematically and publicly recorded. A few of these facts may be mentioned:—It has been found that the per centage of cases is considerable where *gossan* prevails and copper ore is connected with it; and it may be said that the instances are very rare where copper ore is found in fair quantity in a lode, without gossan having been discovered on the "back" or upper part of that lode. This gossan, which is generally mixed with quartz and other mineral substances (among which the oxide of tin frequently occurs), differs much in general aspect; and it is only the eye of the experienced miner that readily detects the character which is most indicative of a good copper lode, and this is one that cannot be expressed in writing.

As to tin in gossan, it is well known that the backs of many copper lodes have, in ancient times, been worked for that metal, so that the upper part of many a copper lode has been worked as a tin lode. It thus appears that an oxide of iron, generally mixed with the oxide of tin, is found in the mineral veins of Cornwall and Devon very commonly above the copper ore.

The greater part of the rare and curious crystalline minerals occur in the shallower portions of the lodes, where gossan abounds, and these rarities are seldom found in connection with large quantities of ore. The search of the mere cabinet mineralogist, therefore, would be in a different part to that of the profit-seeking miner.

However much the surface of the ground may undulate, still the upper parts of the lodes preserve the same appearance, and the gossan overlies the lode in valleys equally as on the hills.

The bunches of tin ore occur much in the same mode of distribution among the quartzose, and other portions of a lode, as do those of copper. It is rarely that any thing which could be termed gossan is seen above a tin lode, where copper does not occur in some abundance; but the connection between schorl and the oxide of tin in the granite districts is very marked, and schorl is a common ingredient in tin lodes in such localities, the minor branches and strings being often composed of quartz, schorl, and oxide of tin.

On the whole, the mixed, compound, and complicated composition which prevails in the earthy and mechanical materials found in lodes, also extends to their metallic contents. Thus, tin ore is found mixed with, and interspersed through (in the most irregular manner) native copper, earthy black copper, vitreous copper, copper pyrites, three compounds of bismuth, and two of iron.

Sometimes the minerals of which the lodes are composed are compact and perfectly solid, at other times they abound in cavities, which cavities may occur in any one of the ingredients, and also of any dimensions—from those of the hollows of a honeycomb, to hollows of several fathoms in length and depth. Sometimes the whole substance of the lode consists of siliceous

minerals, at others the lode is almost wholly composed of ore. It, however, seldoms happens that the alteration from poverty to richness takes place at once and abruptly, but it is generally introduced by the occurrence of small spots of ore dispersed through the other ingredients. The most abundant of the metallic contents of lodes are iron and copper pyrites in every form and proportion.

Although the lodes are sometimes divided by the combs, and by some similar structures, yet the far larger portion of every lode exhibits no trace of any particular arrangement or configuration. Frequently the prevailing mineral runs continuously through the lode for considerable lengths and depths, forming what is called the *leader;* but it is equally common, and perhaps even more so, for all the compounds to be mixed with the irregularity above described.

II.—RELATION OF LODES TO CONTAINING ROCKS.

HAVING considered the internal structure and composition of mineral lodes, we may now notice their relation to the adjacent rocks containing them, which will be found to be important. The miners of Cornwall have studied with much patience the kinds of rocks in which the ores they seek are principally discovered. These rocks they term the *country* of the lode, speaking of a very small portion of ground as a good or bad *country*—and when certain rocks are found to be more favourable for metals than others, they are termed *kindly*; so that, amongst the miners, you hear much talk about *kindly* rocks and good *country*—about a killas (slate) *country* or a granite *country.*

When a variety of beds is traversed by a lode, as often happens, particularly in a slate country, some are far greater favourites than others. In Gwennap, the experienced miners seem to prefer those argillaceous slates which accompany the red or variegated slates of the district, and which have a fine grain and a blue-grey colour. Respecting the value of the red beds themselves, opinions seem to differ, and in most mines the miners have

their favourite kind of rock or country; so that the whole tendency of their experience goes to prove that some particular mineral structures (other circumstances being the same) are more favourable to the production of ores than others. And this kind of observation dates back to early periods; for we find Pryce, in 1778 (*Mineralogia Cornubiensis*, p. 74), mentioning the mining properties of the different kinds of killas or slate. He states that the red is well disposed for copper or tin lodes, the latter preferably. The yellow is indifferently disposed for either. The brown, which has various shades of lighter or deeper colours, is generally a hard stone, and more commonly contains lodes of tin than of copper; but of all killas, the cinereous or pale blue is most desirable as the enclosing stratum of a copper lode. Mr. Henwood says, that slate abounding in tin is uniformly of a thick-bedded, deep-blue colour, and rather glossy.

A good example of ore accompanying a particular set of beds, is to be found in the principal lode of the Fowey Consols mines. In that productive mine the slate dips away from the granite of St. Blazey, on which it rests, towards the east; so that, as the lode has a general east and west direction, the beds traversed by it on the lower part of the mine, on the east, rise to the surface on the western end, and it is found that the bunches of ore accompany this dip, viewing the whole on a large scale, so as to coincide with certain beds.

No verbal description will convey to the reader the precise character of the slate which the miner prefers for copper, although a little practice enables the eye to seize it readily. The slate preferred for tin has a different aspect, being generally duller in its appearance, darker coloured, harder, and more resembling altered slate, which in fact it frequently seems to be. A piece of slate from the tin country of St. Agnes, and another from the best copper mines of Gwennap, or St. Austell, generally differ from each other in a manner perceptible enough to the practised observer.

As regards granite, the miner commonly prefers the somewhat decomposed kinds, in a state to which he applies the term *plumb*—a term much in use in Cornwall to express softness

combined with a fair amount of resistance. A *plumb granite* or *elvan* is more particularly esteemed for tin, though the cases are not rare in which large bunches of copper and tin ores are found in hard granite. Hardness, however, when taken alone, is a quality in rocks which miners do not consider *kindly*, either as to ease of working, or as respects the quantity of ore found in such cases. In granite, a middle grain, with greenish felspar, is considered favourable when combined with some softness. In *elvan*, the softer and more felspathic varieties are most favourable.*

Greenstone, viewed as a whole, in Cornwall and Devon, appears to be unfavourable to the ores of tin, copper, and lead. Though the mines at St. Just may seem to be an exception to this remark, yet the riches of that district are rarely detected in the greenstone itself, and the altered slates there are often mistaken for greenstone.†

In granite, the lodes chiefly productive of tin ore are for the most part composed of a pale-greenish felspar of a confusedly crystalline structure, containing schorl, &c. Through this compound the tin ore is interspersed in crystalline granules small as sand, and seldom as large as a pea.

III.—SIZE AND BREADTH OF LODES.

The veins of Cornwall have no determinate size, being sometimes very narrow, and at others exceeding several fathoms in width—sometimes they extend to a great length and depth, at others, they terminate after a short course. They are continually varying in *breadth*, and this is, perhaps, the most variable and irregular of their characters. Certain portions of some lodes consist of a mere line between the opposing walls, while portions of others are not less than from thirty to forty feet wide. Such extremes, however, are not common in the same lode. At

* None of these signs can be taken as infallible, and it must be borne in mind that the miners in different districts form different expectations from the same signs; so that often those which in one district are thought very favourable, are in another considered very unpromising.

Tincroft, some parts of one lode are but three or four feet wide, while others are thirty to forty feet wide. Those great changes seldom happen within a few feet, or even within several fathoms of each other. It is considered that every lode is *generally* characterised by a commonly prevailing size, which, however it may now and then fluctuate, does so mostly within moderate limits. There are exceptions in parts.

From what has been previously said respecting the country of the lodes, we are prepared to learn that, in passing from one kind of rock to another, lodes frequently change their dimensions, as well as their mineral characters. For example, a lode in granite averaged two feet in width, but on entering the slate it rapidly declined to one inch, and did not again enlarge.

Lodes which yield both tin and copper in mixture, are considerably larger than those which yield either metal singly. Whilst the mean size of tin lodes is about 3·06 feet, and that of copper lodes about 2·93 feet, that of the lode containing the mixture of both, is 4·7 feet, and this greater average breadth takes place in any rock, and at any depth. Generally, a diminution in the width of a lode is a precursor of poverty, and *vice versâ*.

It is also a general fact, that the lodes diminish in breadth in proportion to their depth. The average breadth of the lodes at less than 100 fathoms deep, is 3·97 feet; at more than 100 fathoms, it is but 3·36 feet.

To add a few extreme examples:—A vein containing tin ore in a mine called Whealan Coates, was only three inches wide, but was rich and worth working. Another in Relistian, was upwards of thirty feet wide, and was rich in tin. Some of the copper veins in Herland mine, did not exceed six inches in width, and so continued for a few fathoms; but eventually passed away east and west in mere strings, scarcely thicker than paper, but these veins yielded rich copper. In the next hill, a rich copper vein varied from twelve to twenty-four feet in width.

With reference to the change in the metallic contents of the lode, according to the mineral character of the adjoining rock—in

Godolphin mine, the lodes were productive where the killas was of a white colour, but poor when it was black. In Poldice mine, the lodes in the killas continued productive until they passed into a hard black killas, which *cut* out the riches. In another mine, two lodes were very productive when in soft light-blue killas, but when hard black killas met the lodes, both of them became poor. In Penstruthal copper mine, the lode had been tried at various times where the granite was hard, and always unsuccessfully; a trial, however, was made subsequently, where the granite was soft, and it became the most profitable mine in Cornwall at the period. The mine has since been abandoned; but from 1826 to 1829 inclusive, copper ore was raised from that mine to the value of £132,186.

These facts might be multiplied; but such facts are now well known in mining countries in general. In Upper Hungary, the largest copper lodes are found in fine clay-slate. In Saxony, the silver ores occur in a rock called gneiss; and in the Hartz mines in Germany, certain ores are intimately connected with a particular kind of slaty rock. At Andreasberg, in the Hartz, the veins which pass from argillaceous slate into flinty slate, lose their riches in the latter rock. In treating of the Derbyshire lead veins, I shall mention that, in traversing the limestone and *toadstone** (a variety of trap), they are productive in the former, and unproductive in the latter, by which, indeed, they are commonly cut off, though sometimes found to be continued again in the limestone underneath. In the northern lead county, too, similar phenomena are observable. There the lead mining districts are composed of limestone, sandstone, and shale, in parallel beds, and the lodes produce ore in the two former, while they are unproductive, or cut off, in the latter. On the whole, then, the relation which the containing rocks bear to mineral veins, is highly important to the miner, and requires the careful study of his own particular district.

* While this volume is being printed, *Gold* is found in the toadstone of Derbyshire. Of that subject I may treat in a future volume.

IV.—DIP AND DIRECTION OF LODES.

A.—*Dip.*—This word expresses the inclination of the lode, and its synonym in the northern lead-mines is the *hade* of the vein. Thus the Alstone Moor lead-miners would say of a particular vein, that it is not vertical, but "*hades to the sun*,"* that is, inclines in its lower part towards the south. "*Underlay*" is often used to express the same.

The lodes of Cornwall scarcely ever take a direction quite straight down, or, in other words, quite at a right angle with the horizon; but they almost always dip or incline away from that angle; so that the metalliferous veins which run east and west, dip or underlie either towards the north or south; and the non-metalliferous veins which run north and south, dip either towards the east or west. While this is a general expression, there is no uniformity; for some lodes are nearly perpendicular, others are very oblique. In the small space of one little hill, instances may be found in which veins of almost every description dip or underlie in almost every direction, traversing each other in such a manner as to set at defiance all the previous experience of the miner.

The dip is almost always so irregular, that no straight line can be drawn through the lode itself to connect distant points at different levels. The inclination (not the direction) of the lode changes when it passes from one kind of rock to another, and the richest parts of almost all lodes have the highest inclination.

But the curvatures and irregularities in the underlie of lodes, seem to depend on other circumstances besides the texture and composition of the rocks, and their own richness. One may be the positions which the lodes occupy in relation to the large granitic masses in their neighbourhoods. In 296 examples, Mr. Henwood found a numerical preponderance when the dip, with

* The dip may be defined as the deflection or deviation of the vein from the perpendicular line, or from the horizon, as it is followed in depth; like the slope of the roof of a house, or the descent of the steep side of a hill.

regard to the granite, was compared with that towards either of the cardinal points.

Notwithstanding the very considerable differences which take place in the *degree* of the inclination of a lode in different parts of its course, yet the *direction* of its dip is generally the same. Thus a lode which underlays towards the north, will seldom take a southerly inclination in any part of its bearing, although there are several exceptions to this general rule.

The mean dip of the lodes throughout Cornwall and the west of Devon, may be reckoned at about 70 degrees from the horizon. But in this respect there is a considerable difference between the lodes in the east and west districts. In some few cases the lodes are very flat, and in one so much so, that the lode forms a convenient road for the wheelbarrows of the miners; and, in another, the labourers have access to some parts of the mines by means of steps cut in the foot-walls (lower walls or sides) of the lodes.

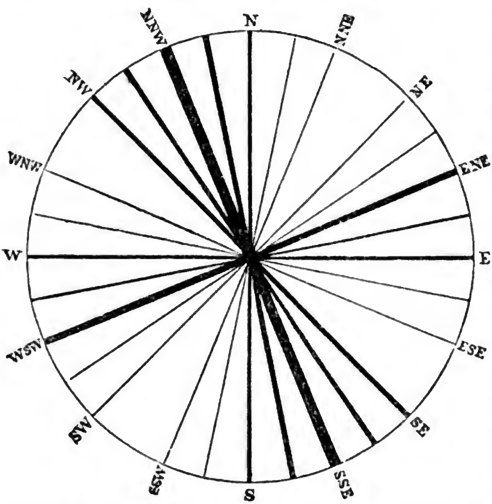
The richer *portions* of lodes are almost invariably nearest to the perpendicular; but it does not follow from this rule, that the lodes which are the most vertical are throughout the richest; nor must it be inferred that the flat lodes are always poor.

B.—*Direction.*—This will be understood to be altogether different from the *dip* of a lode; the latter being its inclination from a perpendicular line, or its underlay; and the former being its general course through the country, as regards the points ot the compass. The difference of the terms is that between deflexion and bearing.

Although the mean bearings of the lodes differ in the different districts, yet when each tract of country is taken singly, there is a general approach to parallelism in its principal lodes. The small differences in their directions are commonly found to occur in spots at some distance from each other. This is the case in the St. Ives and Marazion districts, and especially in those of Helston and Redruth, and also to a certain extent in most of the other districts; for in them the principal or *champion* lodes have a similar coincidence, or the differences in their directions take place in rather distant localities.

By taking the bearings of the lodes in the ten principal mining districts of Cornwall, we find the average of the directions of the whole is 4° S. of W. I shall shortly illustrate this general expression, by naming the directions in some principal districts. The fact that the great majority of the copper lodes of Cornwall have an *east* and *west* direction, is well known to the most ordinary inquirers; as also is the fact, that the tin lodes are generally *east* and *west* veins, ranging from 5° to 15° S. of E., and N. of W.; in some cases due E. and W., and less frequently N. of E. and S. of W. The lodes of the St. Just district bear more to the N. of W. than any other. The maximum of the reverse direction, that is, to the S. of W., occurs in the central portions of the great mining fields of Cornwall, about the Redruth and St. Agnes districts.

The following diagram of the compass circle may be found to assist the reader in his conceptions of direction. The thick line, N.N.W. by S. S.E., represents the predominant direction of *rock fissures* in Cornwall.



If the reader wishes to understand these and the following observations fully, he must needs have before him a good map of Cornwall; if a geological map so much the easier for him; and, best of all, if the Ordnance geological map of Cornwall and Devon, which map may now be found in most public libraries in cities and towns.

In illustrating the above expressions, in relation to the *direction* of the lodes, in the tin principal mining districts, I will present a few particulars.

Beginning with the lodes upon Dartmoor, we find them approximate considerably to E. and W. courses; and toward its borders, on the north-east and south, where mines have been worked, the same direction in the lodes would generally appear.

In the St. Austell district, the same general directions of mineral veins (and cross-courses) is to a great extent observable. The main lodes in Fowey Consols approximate a true E. and W. direction.*

But in this district there are exceptions noted below, and, viewing it as a whole, the most marked lines of lodes are W.N.W. and E.S.E., thence inclining to true E. and W. in the slates on the south-east, &c. One mine, Polgooth, differs from Cornish mines in general, for its lodes so cross each other in one place as to present nearly the appearance of a star.

The direction of the lodes in the St. Agnes district, taken as a whole, is W.S.W. and E.N.E., and considerable general parallelism can be observed among them.

Parallel to the run of lodes in the last district, we find the great mass of mineral veins of Gwennap, Redruth, and Camborne, the two districts being connected in this respect by the lodes on Prince's Common, and other intermediate mineral veins. The ge-

* The direction of the main lodes, which form the Charleston, Pembroke, and Crennis mines, is towards the W.N.W. and E.S.E. The lodes of the Great Hewas mine are nearly parallel to the Crennis lodes. Those lodes which run more W.N.W. and E.S.E., and E.N.E. and W.S.W., form *counter lodes* (so called in Cornwall, or *contre* or *caunter* lodes), coming in from the N. and S. Counter lodes are also found in the Gwinear and Camborne districts, which differ to the extent of from 21° to 75° (the mean difference being 54°) from the directions of the champion lodes in the same mines and parts. Yet they present perhaps no greater difference when compared with the bearings of other champion lodes at distant spots, than these latter do when compared with champions in other places. The counter lodes have no distinctive character, except that of direction. They invariably bear to the north of the champion lodes as they go westward; the mean strike being 31° N. of W. The greatest difference in counter lodes is between those of adjoining mines. Miners, however, too readily call every lode not having the direction of the main lodes a *counter lode.*

neral parallelism of the lodes in this part of Cornwall, is remarkable, and presents a striking feature in its geological structure.

These lodes are more or less traversed by other lines of dislocation, having a general tendency to run at right angles to the W.S.W. and E.N.E. lines. One of the more remarkable of these is termed the "Great cross course," and can be readily traced many miles from Gwennap to the sea on the north. During its course it heaves the country, the lodes included, between seventy and eighty fathoms horizontally. Many other great cross-courses are seen in the St. Agnes and Gwennap, Redruth and Camborne districts, the apparent heave produced by which is in the same direction. One at Piran Porth is considered to shift the country on either side to the distance of ninety-two fathoms. There is good evidence that these north and south dislocations were produced *after* the fissures containing the tin and copper lodes of St. Agnes, Gwennap, Redruth, and Camborne. In a part of the Gwennap district, the country can be considered as little else than a mass of huge fragments cemented together by various mineral substances, the great dislocations having been produced at two different times at least; the last cutting off the continuity of numerous fissures previously filled in part by the ores of copper and other useful metals.

Following the course of the lodes in this great mining portion of the county, we find that the W.S.W. and E.N.E. direction is continued from Camborne, through the north part of Gwinear, into the granite on the north of Penzance. The great leading lode of Wheal Alfred, those of Herland mine, and, to a certain extent, those of Relistian mine, have this direction, which is also preserved in some lodes near Gwythian. Near St. Ives the main lode of Wheal Trenwith and St. Ives consols takes the same course, which may also be seen among Balnoon* lodes. Proceeding along the coast from St. Ives to Morvah, many lodes are found coinciding in the same direction; and, in the interior, the two main lodes at Ding-Dong tin mine take the same course, so that the St. Agnes and Gwennap line of fissures may be traced nearly to Morvah.

* Remarkable for its capricious distribution of tin ores.

The same directions, W. S. W. and E. N. E., will be observed in the lodes at Penance-mill, near Falmouth, Wheal Vyvyan, near Constantine, and in several mines near Wendron, which serve to show the general course of the mineral vein fissures in these localities, connecting them with the Gwennap line of lodes. The same direction is also conspicuous in the Wheal Vor, Great Work, and several other lodes in the north of Breague. The great lode which runs from Godolphin-hill to Trevean Cove takes a similar course, as does also one of the principal lodes near Retallack.

The Breague and Marazion country is, however, crossed by another line of lodes, reminding us of the line of the St. Austell lodes; and the direction of these is very complicated in detail. They cannot, therefore, be well described in such an account as the present, which is not intended to detail or explain the intricacies of the subject.* At the Marazion mines there are some curious examples of lodes parting and meeting again.

After studying the whole of these phenomena, as laid down on a plan or map, and after generalizing the various facts connected with the directions of the common faults, mineral veins, and cross-courses, as exhibited on a prepared map of Cornwall, we find on the east a tendency of nearly north and south lines to cross others running east and west; while on the west, lines which have frequently a N.N.W. and S.S.E. tendency, cross others, which run either from W.S.W. to E.N.E., or from E.S.E. to W.N.W.

Again, we cannot fail to observe the general coincidence between the lines of tin and copper veins, and those of the elvan courses. It is true that the mineral veins often cross the elvans, and at Polgooth, near St. Austell, the elvan is considered to traverse the mineral veins. But viewing the subject as a whole, there is a certain marked coincidence between the lines, which would seem to point to the fact that the land was fissured, and the fissures so produced filled up by granitic matter, before

* These may be seen noticed and illustrated in Sir H. Delabeche's Geological Report on Cornwall and Devon, (Longmans, 8vo, 1839), on the authority of which I rely for several of the above facts.

those now containing the abundant ores of tin and copper were formed. The tin and copper veins near Tavistock have nearly the same direction as the elvans and general run of granitic matter of Kit-hill. The same may be said of St. Neotts and St. Austell (excepting Polgooth); and in the St. Agnes, Gwennap, Redruth, and Camborne districts, the general coincidence of the lines of bearing of the tin and copper lodes with the lines of the elvans* is particularly remarkable. This parallelism may be traced from the latter through part of Gwinear to St. Erth, and thence into a part of the Land's End granite.

For the most part, we have direct evidence that the elvans generally were consolidated before the fissures containing the ores of tin and copper were formed, inasmuch as the latter are continued through the former, in the same manner as through any other rock which they traverse; and it would appear probable that the fissures filled by elvans were chiefly produced after the consolidation of the granite, for we have the fissures which contain the greater portion of the copper and tin ores of Devon and Cornwall, taking general directions coincident with lines of pre-existing fissures. If granitic matter extends beneath a considerable part of the metalliferous districts of Devon and Cornwall, we have the lines of elvans and principal tin and copper lodes upon a great back of pre-existing granite, at first taking a western course from Dartmoor to the Brown Willy and Hensborough bosses, then striking down W.S.W. to the Land's End and Scilly Island granites. Taking a view of Cornwall from east to west, if a line were drawn in such direction through the centre of the county, we might trace a parallelism to it in the line of the lodes themselves.

Although lodes in passing from one kind of rock to another frequently change their dimensions, as well as their mineral characters, and also their dip or inclination, yet the same does not hold true of their *direction*; for, as Mr. Henwood has ob-

* Having already explained the character and course of the *elvans*, it is almost unnecessary to repeat here that the word is a local term for courses of porphyry and claystone; but the term is often taken more generally to include fissures filled with granitic matter.

served, "the passage of lodes from one rock into another, is seldom if ever attended by any change in their direction. Whether they traverse granite or elvan, it seems in no case to influence their *bearing*, which rather appears to depend on some circumstance peculiar to the district, than on the nature of the containing rock. When, however, the two different rocks unite, the lodes not uncommonly run for a few fathoms between them." Nor do the courses of the lodes (except in the St. Just district) appear to exercise any influence on the composition of the containing rocks. From such facts, fair and important geological inferences as to the comparative age of the lodes may be deduced.

V.—CROSS-COURSES, OR CROSS-VEINS.—THEIR CHARACTER AND COMPOSITION.

I have already, in passing, spoken of the cross-courses in the central districts, &c.; but it is desirable to give some further information on these courses, though it will be as compressed as possible.

These are courses or veins which, with rare exceptions, yield neither tin nor copper ores, and are locally termed "*cross-courses*" when composed of quartz, and "*flucans*" when composed of clay; but it is simpler to term both kinds *cross-veins*.

Veins having similar directions to the cross-veins, are often productive of lead ore (in Cornwall), but rarely so, unless they are at a considerable distance from the lodes, when they are profitable. These cross-veins yield by far the largest portion of lead and iron ores found in Cornwall; and most of, if not all, the lead (galena) found in cross-veins, is combined with silver.

Cross-veins derive their name from their direction, which is, as the mean of several observations, 38 degrees north of west, and therefore these veins run across the metallic veins; for, as above stated, in the ten principal mining districts, the mean of the direction of the metallic lodes is four degrees south of west.

The same cross-veins are occasionally traced through several mines; but they are seldom thus recognised at distant spots, and scarcely can the same cross-vein be really traced into adjoining districts. An apparent exception is the great cross-course, which leaves the lodes in Wheal Peever for 72 fathoms, and which, it is said, can be traced southward to the British, and northward to the Bristol, Channel.

Cross-veins have several features similar to those of mineral veins, for they sometimes split into branches, and dwindle and disappear both in length and depth; and they are also composed of very dissimilar substances in different spots. One of the remarkable facts in their structure is a prevalence of joints; another is an irregular crystalline arrangement of the quartz in their quartzose portions, the axes of the crystals being disposed across the vein. In the granitic tracts, many of the cross-veins consist almost entirely of granitic matter, commonly in a state of disintegration. As the cross-veins generally intersect the lodes when they meet, their quartzose portions afford almost the only uninterruped natural channels for the circulation of water underground, and hence the rock is softer in their vicinity. When, however, they are filled with clay (flucans), they act as water-dams, on which account mining leases are often bounded by cross-veins. They have commonly a prevailing size, and their average breadth may be taken at four feet; and, it may be, five feet in granite, and 3·62 feet in slate. The lodes generally change their composition with a change of dip and size; but, on the contrary, cross-veins seem to be unaffected in their composition or structure by a change either in inclination or bulk.

VI.—INTERSECTIONS OF LODES.

These may take place either by cross-veins or by other lodes, and either horizontally or vertically.

A.—*Horizontal Intersections of Lodes by Cross-Veins.*—The intersections of large lodes by large cross-veins present a *maximum* extent of horizontal dislocation—which in Cornwall is termed a *heave.* The intersections of small lodes by small

cross-veins present a *minimum* extent of heave; while those of a large and small vein of either kind afford nearly a mean.

This branch of inquiry is very complicated, and when followed out embraces many details; such as the following, under the head of ***Heaves*** or horizontal displacement:—1. The composition of the intersected vein—2. The composition of that intersecting it—3. The nature of the containing rock—4. The widths of the intersected and intersecting veins—5. Their horizontally included angles—6. Their inclinations—7. The extent of the heaves at different depths—and several other similiar inquiries. The determination of these questions would apply equally to—(1) the intersection of lodes by cross veins, (2) to the intersection of cross-veins by lodes, and (3) to the interference of lodes with each other. Vertical intersections would require similar consideration.

Without entering into any such minute and complicated details as the above, and others connected with other branches of the inquiry, I will only add a few general inferences from numerous observations:—It is a general rule, that the heave of the *same* lode by the same cross-vein is in the same direction, or towards the same hand, at all depths; and it may be taken as a safe general rule that the heaves of *all* lodes by the same cross-vein are in the same direction. The intersection of one lode by several cross-veins is not uncommon, but the results bear little or no relation to each other.

It appears that a very large proportion of the intersection of lodes by cross-veins takes place at great angles, as from seventy to ninety degrees.

The extent of the heaves become smaller as the included angle between the intersecting veins become larger.

There is an angle at which the extent of the heaves rises to a maximum, and that angle is between forty and fifty degrees; but, on either deviation from it, whether the included angle be greater or less, the extent of the heave diminishes.

B.—*Vertical Intersections.*—These are commonly called *leaps,* or *throws*, and the results of such intersections are, that one vein either simply traverses the other, or dislocates and displaces the other. In the latter case the displaced portion is found by

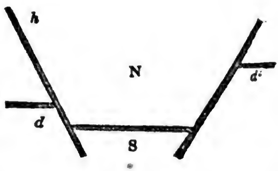
following the line of the traversing vein either upwards or downwards. These kinds of intersections are less important than the horizontal, because few in number.

The inquiries respecting them are limited to—1. The nature of the intersecting vein; 2. That of the vein intersected; and, 3. The influence the angle at their intersection may have on the direction or distance of the *leap* or *throw*.

I now add some illustrations of the displacement of lodes.

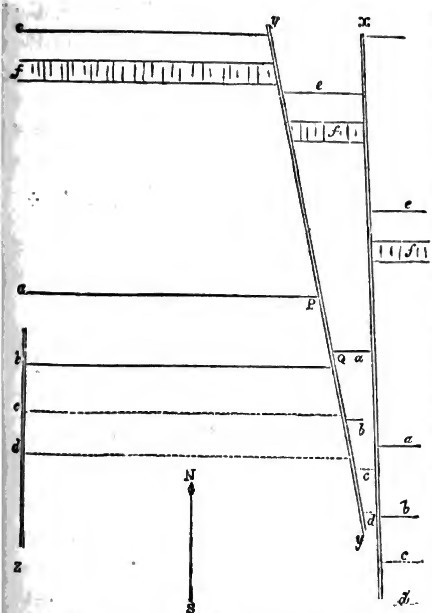
At Polgooth mine the flucan intersects the little elvan and St. Martin's lode, and, on both of these, occasions a leap of 114 feet upward to the smaller angle.

The great copper lode of Carharack, in the parish of Gwenap, affords an instructive example of intersection.



The thickness of the vein is eight feet, its direction is nearly due east and west, and it dips towards the north at an inclination of two feet per fathom; its upper part being in the killas (a greenish clay-slate), and its lower part in the granite. The lode has suffered two intersections; the first produced by meeting the vein *h*, called "Steven's flucan," which runs from north-east to south-west, and which throws the lode several fathoms out; the second is produced by another vein, *i*, almost at right angles with the first, and which occasions another out-throw of twenty fathoms to the right side. The fall of the vein occurs therefore in the one case to the right, and in the other to the left; but in both it is towards the side of the obtuse angle. This disturbance is very singular; for one part of the vein appears to have mounted while the other has descended. N. S. denote north and south, *d* is the copper lode running east and west, *h i* are systems of clay-slate veins (flucans). The line over S. represents the down-throw, and *d* the up-throw.

There is one case of intersection in Cornwall which has for some time been considered a sort of mining puzzle, and in fact several practical men were baffled by the perplexity of the phenomena. A simplified view of it may be presented in plan and



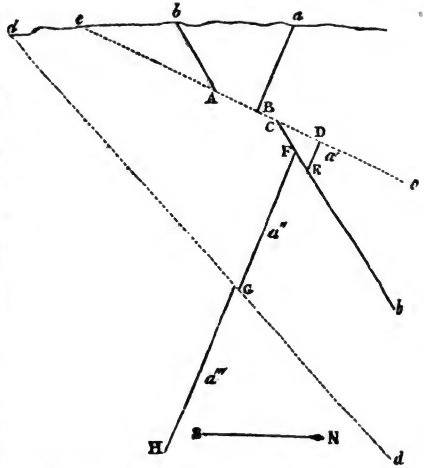
section, to explain this very curious instance. The mine is called Wheal Peever, and the adjoining figure represents the ground plan:—Now here are to be seen six parallel courses, viz., a tin vein, two copper veins, an elvan course, and two "slides;"—all these are shifted to the north of the cross-course *y*, and again still farther to the south by another cross-course *x*, each through the same horizontal space.

In this ground plan, the references by letters are to be explained as follows:—

a, a, a'', tin vein worked.	*e*, Copper vein.
b, b', copper vein, called "John's gossan."	*f*, Vein of clay ("elvan.")
c, North "slide."	*x, y, z*, Cross-courses.
d, South "slide."	

The subjoined figure is a vertical transverse section taken from north to south, exhibiting the same veins. Now it is seen that the two "slides," *c* and *d*, pass through, and interrupt in their inclined courses both the copper vein *b*, which is inclined in the same way (to the north) as the slides, and the tin vein *a*, which is inclined in the contrary way (see points marked A B C D G). It is also seen that the copper vein *b* passes through and displaces the tin vein *a* (compare points F and E). Moreover, it appears that, excepting the displacements from A to C, B to D, and F E, and at G, there is no irregularity, the divided parts of the vein being respectively parallel.

Respecting the geological problems in this curious case, the ordinary explanation is, that the tin vein now appearing in the parts *a*, *a′*, *a″*, *a‴* is the oldest vein, and was formed in one straight line. After its formation, the copper vein *bb′* was formed by filling a straight continuous fissure, which was made by violent fracture of the mass of the rocks across the tin vein. This was accompanied by a dislocation of the rocks inclosing the tin vein, so that the line was broken, and the parts separated by the distance F E. At some later period, the slide *c* was formed by a similar fracture and displacement, crossing both the copper vein and the tin vein, and shifting the parts of them both, so that the copper vein was divided into two parts *b* and *b′*, separated by the interval A E; and the tin vein again divided, and its parts *a* and *a′* separated by the interval B C (which is equal to A C). At the same, or some other time, the slide *d* produced a slighter effect on the tin vein *a* at G. Finally, after all these fractures, three fissures in a north and south direction, *x y z* in the ground plan (not seen in the vertical section), have been formed across *a*, *b*, *c*, *d*, *e*, *f*, and have been accompanied by dislocation in a horizontal direction along nearly vertical planes.



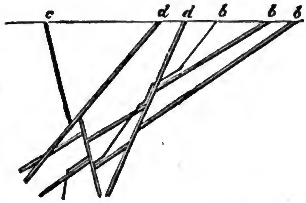
Such complicated phenomena are only to be clearly apprehended by a model. I fear the reader may think I am here presenting to him the *pons asinorum* of the mineral Euclid; but if these movements seem puzzling in their representation on paper, how much more so must they be in the real situation, where every line must be traced with difficulty in the first

instance! This case has been appealed to by some Cornish geologists, who have revived the opinion of Stahl, that the veins are contemporaneous with the rocks; but others (as Professor Phillips) thinks it confirms the opinion, that veins are posterior to the rocks which they traverse, and of unequal antiquity as compared with one another.

As a general fact, it is thought that the meeting of lodes with lodes at a small angle, is a sign of productiveness.

Several instances of the interference of veins with veins of metal might be mentioned. I will only, however, exhibit one other.

At Trevannance mines, the two systems of tin veins are both intersected by the oldest of the copper veins, indicating the prior existence of the tin veins. In the figure here given, *b* marks the first system of tin veins, *c* the second, and *d* the east and west copper veins. This may suffice as an example of the kind.



Several circumstances seem to intimate, that in intersections, whilst the dimensions of the veins and the angles they include regulate the *distance* of the displacement, their mineral characters in some degree influence its *direction.* In no instance of vertical intersections has the same vein been seen to intersect another more than once, or to interfere with more than one vein on the line of its dip.

Many attempts have been made to deduce a general law in relation to the *continuance* of intersected veins in the direction of the angles made by the intersection. So much uncertainty prevails, that I should hesitate to state any presumed law as general, though I may add that, both in Saxony and Cornwall, it is considered to be a general law, that in intersections of veins the portion thrown out is always upon the side of the obtuse angle, and the more obtuse the angle the more considerable is the out-throw. This is exemplified in the case of the great copper lode of Carharrack, above illustrated.

The meeting of two lodes either in depth or in a horizontal direction, is generally considered advantageous to the production of ore, more particularly when the angle at which they meet is small, or not great. But there is too great a lack of information as to the actual phenomena, to enable us to arrive at any general expressions of results from such meetings. Many an instructive page in the book of mineral problems is opened by the operations of the miner, but it is opened only to be closed again; and the valuable lessons it would convey to the scientific observer, are again buried in the thick gloom of subterranean night, never to be again visible, unless some future adventurer shall waste his time and capital in ignorantly re-opening—as has often been the case—exhausted mines. On this topic, for example, the simple circumstance of the meeting of the lodes, and the amount of the angle between them, is of course well known, and whether both lodes were fairly rich, or one only had that character; but the exact character of the lodes at their junction, and at short distances from it (with a variety of other attendant circumstances not usually observed, and which are nevertheless very important), are phenomena rarely noted with sufficient accuracy, and, even if observed, very rarely recorded, so that, upon removal or decease of the agents or miners, the lessons of nature are lost for ever.

VII.—MISCELLANEOUS OBSERVATIONS RELATING TO PRODUCTIVENESS.

I may conclude this part of my inquiries by stating some generally received facts, in relation to the productiveness of mineral lodes, which do not exactly fall under any of the preceding heads, though closely connected with them.

"*Ore against Ore.*"—Whenever a lode is rich, if there be another lode near it, having nearly the same direction and in the same *country*, whatever be the rock, it is probable that the second lode will be found rich in that part which is opposite to the rich part of the first lode—hence the proverbial phrase, "*Ore against Ore.*" This fact may be expressed either in the

above simple form, or more accurately by saying, that lodes in almost every district are productive on similar lines taken at right angles to their bearings, or that parallel lodes are richest on the same meridian.

This proverbial phrase was very early in use, and has been one of the first acted upon in mining pursuits; but we now have this important fact well confirmed. Even the corresponding parts of other veins, parallel to those which have been rich, have been thought more likely to be productive than other parts of the rich lodes themselves.

Influence of Elvans.—When elvans and tin and copper lodes occur together, they are found in connection, as a whole, with good mines. An experienced mining captain has remarked, that most of the ore in the principal mines in Gwennap (which is the great copper-bearing parish of Cornwall), has been found in or near large elvan courses, and the particular mines are named as instances of this fact.

The effect of elvan courses is not confined to those of them which cut through slate—though it is more obvious in such localities. Elvan is found in connection with the great copper lode in granite at Tresavean, and not unfrequently elvan courses in granite are accompanied by oxide of tin. Tin ore is frequently met with in connection with elvans among slates, and the backs of these dykes may not unfrequently be seen to have been torn up in ancient times for the oxide of tin, when the ore was sufficiently near the surface to pay for working. At Tregurtha mine, near St. Hilary, a multitude of strings of oxide of tin occurred in the elvan traversed by the lode, being apparently minute splits from the main fracture.

Under the head of *Direction*, I have mentioned the general coincidence between the lines of tin and copper lodes, and those of the elvan courses. The connection, too, between *bunches* of tin and copper ore in fissures, and those places where the latter traverse the elvans, is of the most marked kind when the subject is viewed on a large scale. A noted example of this fact occurred in a mine now abandoned, namely, Wheal Alfred, near Gwinear, where an elvan dyke of about 300 feet thick was met

with, having a direction about N.E. and S.W., and dipping N.W. at an angle of 45°. The lode dipped at an angle of 72° to the north, traversing the elvan obliquely in its descent. This lode produced some ore in the slate, but on entering the elvan it became much richer, and, increasing in value in the same rock, it yielded ore sufficient for a profit of £140,000 to the adventurers. After quitting the elvan it became poor, and thus the mine was abandoned. In the slate above the elvan, the width of the lode was from six to nine feet, in the elvan it increased to twenty-five feet, in the slate beneath it decreased to ten feet. Not a few of the larger and wider bunches of ore, both tin and copper, have occurred in the immediate vicinity of cross-courses and flucans, and frequently, also exclusively, on one side of their intersections, in the numerous examples of the intersections of elvan dykes.

Influence of Depth.—It has been generally thought that depth below the surface of the earth is influential on the quantity and quality of the ore contained in the veins. Pryce, writing in 1778, says, "The richest strata for copper ore is between forty and eighty fathoms deep; and for tin, between forty and sixty; and though a great quantity of either may be raised at eighty or a hundred fathoms, yet the quality is often decayed or dry of metal." This *dictum* of Pryce does not seem to be confirmed by more recent experience; for in some instances, as in Dolcoath mine, we have gone to the depth of 200 fathoms without exhausting the supply; and Tresavean mine has been worked to great profit, at more than 320 fathoms from the surface.

It is, however, a common opinion in Cornwall, that copper, on the whole, occupies greater depths than tin. Mr. W. Phillips, the late mineralogist, observes, "At about 80 or 100 feet under the surface, the first traces of copper or tin are found, rarely nearer to it than eighty feet. If tin be first discovered, even without a trace of copper, it is not unusual that in the course of sinking 80 or 100 feet, or more, all trace of it is lost, and copper only is found. But if, instead of tin, copper be first discovered at a depth of 80 or 100 feet, it seldom or never appears that tin is found below it in the same vein." Yet tin

is sometimes found 100 feet deep without a trace of copper. Mr. Fox adds, "There are, however, many instances of tin ore accompanying copper ore to a great depth; and in Dolcoath mine it is found in a copper lode more than 200 fathoms below the surface, and even under the copper."

It is mentioned by several mining inquirers, that mineral veins are generally richer near the surface than at great depths. This is particularly the case in the mines of the precious metals in America, where the greatest quantities of ore have been found near the surface. This fact has been explained by the theoretical assumption, that the mineral substances, brought by sublimation from the interior of the earth, were naturally deposited where the temperature was lowest, at or near the surface, in the rocks among which they are situated.

TEMPERATURE OF ROCKS AND VEINS.

Mr. Henwood has made some useful and careful remarks on this topic, and the following table will present some results of his inquiries:—

MEAN TEMPERATURE OF THE ROCKS, CROSS-VEINS, AND LODES, AT NEARLY EQUAL DEPTHS.

DEPTHS.	ROCKS.		CROSS-VEINS.		LODES.	
	Depth. Fathoms.	Temperature.	Depth. Fathoms.	Temperature.	Depth. Fathoms	Temperature.
Surface to 50 Fathoms..	30·	55°·52	31·	53°·76	29·	54°·83
50 to 100 "	70·	60°·2	76·	61°·2	71·	59°·87
100 to 150 "	134·	69°·66	115·	64°·75	126.	66°·88
150 to 200 "	180·	82°.11	163·	74°·4	161·	72°·41
200 Fathoms and beyond	235·	87° 9	220·	88°·75	246·	88°·57
Mean........................	111·	67°·55	99·	64°·82	111·	66°·04

It was also proved that at 230 fathoms depth, and beyond, *tin lodes* have a temperature of 74°·3; copper lodes were 89°·14; and lodes yielding both tin and copper have a temperature, at a depth of 171 fathoms, of 81°·75, as inferred from four observations.

One cause of the irregularities in temperature is, that in very few instances do equal depths below the surface hold the same

position with regard to the sea level, since the situation of mines differs in elevation; but there are other causes depending on the geological character of the rocks and veins, which seems visibly to affect the temperature, as may be inferred from the above table and statements. The working miners of Cornwall have long known that the lodes containing tin ores are, as regards depth, colder than those in which copper ores occur; and several observations go to prove that tin lodes possess the lowest temperature, and copper lodes the highest, whilst the lodes containing both metals hold an intermediate temperature.

The result of numerous observations discloses a progressive elevation of temperature, as we descend in the crust of the earth. From the surface to 150 fathoms deep, the rise of temperature for equal increments of depth seems to occur in a diminishing ratio; but deeper observations reveal the curious and anomalous circumstance, that, at more than 150 fathoms deep, the progression again becomes more rapid, and that the ratio at about 150 fathoms in depth is at a minimum, and increases both at greater and smaller depths.

ORIGINAL FORMATION OF MINERAL VEINS.

This is mostly a subject of geological theory; and therefore, although I think it proper to make a few remarks upon it, yet these remarks must be brief and elementary, so as to comport with the plan of this work. The inquiry is necessarily obscure and difficult.

A.—*Time of formation of Veins posterior to Rocks traversed.* —That excellent German geologist, Werner, asserted as a truth, that veins are of posterior date to the rocks which they traversed, because they fill fissures in them. He examines the point fully, and finally establishes the origin of veins by the filling up of originally open fissures, as a fundamental truth of theoretical and practical importance. He offers nine proofs in support of this statement, and though not now thought to be skilfully managed, yet they appear conclusive as far as regards the phenomena described by him, and commonly met with in mining experience.

Practical miners very generally agree with Werner on this statement, and I have alluded to it in the preceding observations. There are, however, some serious objections brought against this theory, from cases in Cornwall, which might be resolved into the three following classes:—

1. The mechanical difficulty of explaining the movements of the masses of rock in which the veins lie, is more considerable in Cornwall than in any other mining county yet investigated. Add to this, the excessive abundance of veins, and the variety of direction, inclination, and inequality of apparent displacement which they manifest. Compare the above illustration of the puzzle at Wheal Peever mine.

2. It is urged that the affinity between certain rocks and the veins in them is real, and sometimes leads to an intimate union of their substance by mutual penetration; to which Werner replies, that in general the vein and the rock are distinct and separate from each other, and that the asserted intimate union only takes place in certain parts. To this of Werner, Professor Phillips adds, that the specific affinities which the contents of one vein display to the different rocks which bound it (as in the lead mines of the north of England), when rightly viewed, offer a most convincing proof that the substance of veins was introduced among these rocks *after* they had acquired such conditions of hardness, position, &c., as to exert unequal powers in determining the arrangement of the mineral substances in the mineral veins.

3. The objectors allege that strings and branches of metallic ores and sparry substances, like those which occur in veins, but inclosed on all sides in rock, are of sufficiently frequent occcurrence to demonstrate, that all mineral depositories have not been *open fissures*, filled by depositions from above, as Werner taught, or by injection from below, as Hutton contended, or by mere sublimation, as other writers have advanced on good, though limited, evidence.

Replies of weight are also made to these objections, and a curious circumstance is mentioned as part proof of cracks and cavities having existed as such in the limestone of the north of

England, *before* the introduction of their crystallized contents; viz.,—that some of these cavities are the inner hollows of bivalve shells (*Producta*), which shut close and have no opening—and others are the closed chambers of shells (*Orthoceras*, a *Cephalopod*). A string of metal (lead) often forms in encrinal remains, and may be found in the "screwstone" of Derbyshire. The conclusion of Professor Phillips is this—"Upon the whole, whether the mineral substances occur in distinct regular *fissures* or only plane *joints*, lie in irregular *cracks* or holes of rock, or line secret hollows in shells—in all of these cases, the existence of a cavity to receive the crystallized substances is demonstrated as the most *ordinary* antecedent to the production of the mineral mass. It follows as a consequence then *ordinarily*, when veins cross, and one passes through and divides the other, the "cross-vein" is of later origin than that which is cut through.

B.—*Origin of the Mineral Vein Fissures.*—Having thus far separated to a certain degree the theory of the origin of the veins from that of the rock in which they lie, the next thing to be determined is, the origin of the fissures in which the metallic and other mineral combinations have been effected.

The fundamental facts for reasoning from, are the already noticed prevalent parallelism of direction of the several systems of veins in a given district, which belong to successive periods of formation; the penetration by these fissures through a great variety of rocks; their length on the surface (some extending several miles); their depth, which in large veins exceeds the range of mining enterprise; the displacements of the rocks which they divide, and their various intersections and mutual relations.

Having, in the sectional observations on lodes, enumerated and illustrated several of these fundamental facts, it would be superfluous to re-open the inquiries here, simply for the purposes of theory. A great point is to ascertain if the apparently peculiar phenomena of vein fissures can be referred to general laws, which extend beyond the mining districts. It is thought that such reference can be made to general laws in the similar parallelism of structural fissures, passing through various rocks for greater lengths than in mineral veins, and to unknown

depths, with the same variety of mutual relation. Such are rock dykes, and the symmetrical structures of rocks called joints and cleavage. The most prevalent direction of Cornish veins, east by north, is that of certain characteristic joints in a considerable portion of England. The lines also of the great cross-courses of the Penine Chain, Flintshire and Cornwall, viz., north and north-west, are also coincident with a very general divisional structure of the rocks in most parts of Great Britain, and several other parts of Europe. Mr. Henwood expressly states, that the cross-courses and principal veins coincide more or less with the lines of symmetrical structures by which all the rocks of Cornwall are divided.

It is evident, however, from several circumstances, that it is not merely by the filling of joints of the rock that veins and dykes were produced; for the rocks have been disturbed in position, and opened to a greater extent than the original divisional structures, or else these last are only to be regarded as minor effects of great disturbing causes, which broke the strata along the line of fissures of veins and rock dykes. Some observations might be adduced to show that symmetrical divisional planes, such as joints and cleavage, are due to other causes than disruption of the strata. This whole branch, however, must be considered as still needing much patient study and inquiry, and the generalization of accumulated facts.

C.—*Filling of the Vein Fissures.*—The Huttonian hypothesis of the earth's construction, opposed in almost every point to that of Werner, naturally conducted to a different interpretation of the same facts. According to the former, the fissures were preserved by forces depending on subterranean heat, and were filled by injection like rock dykes; and the parallel bands in the vein, which Werner ascribed to *successive aqueous deposition*, were referred by Hutton and Playfair to *successive igneous injection.* In support of this explanation, and as fatal to the Wernerian view, the Huttonians urged the acknowledged impossibility of solution in water of native, sulphuretted, and oxidized metals, and many of the veinstones; and this was alleged to be favourable to the Huttonian view.

But the complicated phenomena exhibited by veins, led some English writers, who admitted the posteriority of veins to the rocks which inclose them, to suppose their contents to have been collected from the neighbouring strata by some peculiar process of segregation, depending upon electrical currents. It was supposed that the successive deposition, and peculiar positions of the various substances which occur in veins, might then be accounted for. This vague suggestion of electrical agency, in depositing the materials of mineral veins, has been reduced to a regular system by Mr. R. W. Fox, residing in Cornwall, who, by uniting the knowledge of veins to patient zeal in conducting experiments, has arrived at most valuable results. He has successively matured his views, and advanced his experiments, until they have attracted very general attention.

Mr. Fox assumes, as sufficiently proved, the origin of fissures from various causes and at various intervals, and their enlargement from time to time; the progressive filling up of such fissures; and their penetration to great depths and regions of high temperature. He shows the probability of the circulation of heated water in them by ascent and descent; and the deposition of quartz and other earthy substances in cool parts, which had been dissolved by the water in hotter parts. In such fissures, filled with metallic and earthy solutions, the different sorts of matter on the sides must necessarily produce electrical action, which might be exalted by the peculiar distribution of temperature. The currents of electricity generated would pass more easily in the fissures than through the rocks, and in directions conformable to the general magnetical currents of the district. These would be east and west, or somewhat north or south of these points, according to the position of the magnetical poles at the period when the process was going on.

Electrical currents thus circumstanced would deposit the bases of the decomposed earthy and metallic salts on different parts of the rocky boundaries of the veins, according to the momentary electrical state and intensity of the points; on which conditions the *nature and position* of the rocks would be influential. When by such processes particular arrangements

had taken place, new actions might arise, and secondary phenomena, such as the transformation of ores *without change of form*, which are otherwise very difficult to understand. Lateral rents might also be filled by virtue of these new actions, even though they were not in the most favourable lines of electrical circulation.

This general hypothesis being admitted, it appears to follow, that the observed influence of cross-courses on the quality and abundance of particular accumulations of ore in the veins which they divide, affords strong ground to believe that, in such cases, the deposition of these ores was subsequent to the displacement of the vein fissure by the cross-course. Mr. Fox seems to think that the clays in the *flucans* and cross-courses were introduced mechanically and not chemically, and that they affected in a particular manner the metallic distributions.

A striking argument in favour of Mr. Fox's electrical theory of mineral veins is, that he formed experimentally many well-defined metalliferous veins on a small scale by voltaic currents, operating under circumstances expressly arranged to imitate those which really occur in Cornwall.*

The peculiar and characteristic arrangements of the ores deposited in veins seem most probably due to electrical action, and this theory is now generally received. Perhaps the principal problem now remaining is to determine whether, as Mr. Fox believes, the electrical currents were voltaic, generated by the chemical action of particular solutions on particular substances; or thermo-electric, depending on the application and conduction of heat. Experimental research, as far as it at present proceeds, in the labours of Becquerel, Crosse, Fox, and Bird, appears to give the advantage to voltaic electricity as the agent of arrangement in metallic deposits. The other source of electrical power has been less inquired into in relation to this topic; yet many circumstances lead to the belief that thermo-electric currents, however weak in intensity, are *now* important in their mineral agency, and may *formerly* have been much more so.

* *See* Reports of British Association for Science, 1838.

The above remarks chiefly apply to the *arrangement* of the substances in the vein; but the *accumulation* of these substances may arise from very different causes. In some cases it really appears that a complete account of the accumulation of the substances is very difficult to collect, unless we call in successively the solvent powers of water and heat. The formation of *sulphurets* is obviously one of the most important of all the facts requiring explanation in mineral veins, because a very large proportion of metallic ores (excepting principally tin) appears in this state. Heat by sublimation, and sulphuretted hydrogen by decomposition of metallic salts, *may* give us the sulphurets; but in the latter case, from what prior condition is the sulphuretted hydrogen derived? Mr. Fox proposes as an answer, the decomposition of other sulphurets by electrical action. Thus, however, we make no advance, and again turn to the simple action of heat, which in like manner stops at the *origin* of these sulphurets, and only accounts for their *transfer* from the deeper parts of the earth. This perhaps is, in brief, the amount of our present knowledge of *the origin of the metallic ores*. We only *know* that they have been transferred from the interior of the earth towards its surface, principally along the fissures opened by violent movements.

Mr. Fox has long since shown that electrical currents flow through all metallic veins. The magnetism of the earth is presumed to be owing to electrical currents circulating through its mass, in a direction at right angles to the magnetic meridian. Now, as the different substances of which the earth is composed are in different states of electro-magnetism, and are often interrupted by non-conducting rocks, the electric currents, being stopped in their course, act chemically on all the liquids and substances they meet with. Hence Mr. Fox concludes, that not only the *nature* of the deposits must have been determined by their relative electrical conditions, but that the *direction* of the metallic veins themselves must have been influenced by the directions of the magnetic meridians. In fact, almost all the metallic deposits in the world lie in parallel veins or fissures, tending from east to west, or from north-east to south-west. Thus we see some key to the origin of the phenomena of the

direction of veins, which have been detailed above, and also why the veins crossing the metallic lodes at right angles are generally non-metalliferous.

While the foreign chemists Becquerel and Mitscherlich have succeeded in producing crystals by electricity, Mr. Crosse has obtained calcareous spar from water which was percolating through a limestone rock, and was forming crystals at the place where it was thus procured. The same gentleman produced crystals of quartz. The electrical apparatus was extremely small, but kept in operation for a long period—the very mode in which it is thought the like results were produced in nature.

Various observations lead us to conclude, that the substances foreign to veins with which they have been filled, have probably been disseminated in atoms in the adjacent rocks, and acted upon by sublimation. At all events, it is known to be certain that the minute particles of matter are constantly in motion, from the action of heat, mutual attraction, and electricity. In this way prismatic crystals of salts of zinc are changed in a few seconds into crystals of a totally different form by the heat of the sun. Casts of shells are found in rocks (as mentioned above), and the animal matter having been removed from them naturally, its place is supplied by mineral matter. The excavations made in rocks sensibly diminish in size in a short time if the rock be soft, and in a longer time if the rock be hard. These circumstances show a continual motion of the particles, not only in their relative positions, but in space, which there is every reason to attribute to electricity.

Sir Henry De la Beche conceives that the continued expansion and elevation of an intensely heated mass from below, would occasion numerous vertical fissures through the superincumbent strata, within which some mineral matters may have been drawn up by sublimation, and others deposited in them when held in solution, by ascending and descending streams of water. But, even on this hypothesis, the direction of the rents, and the deposition of the minerals, would be influenoed by the electrical currents. If veins were filled from below, the richest

veins would be lowest, which is not the case in Cornwall, Mexico, or Peru. The *primum mobile* of the whole, as Mrs. Somerville observes, lies probably far beyond our globe, and we must look to the sun's heat, if not as the sole cause of electrical currents, at least as combined with the earth's rotation in their evolution. Rotation alone produces electrical currents in the earth.* I have already shown that the prevalence and richness of mineral veins are intimately connected with the proximity or junction of dissimilar rocks, where we may suppose the electro-molecular and electro-chemical actions are most energetic. Yet electricity would not exactly solve all our questions with regard to the sparry contents of veins—and, probably, different causes must be referred to. Aqueous solution of some of their materials is possible, but of some it offers no sufficient account. Some, as salts of lime, abounding in a limestone country, may reasonably be attributed to the action of water passing through the rocks. Others, as quartz, may be thought to require much heat for their solution. The clays and the rolled fragments mark the mechanical action of water. Thus, on the full view, it appears that the whole character and phenomena of mineral veins are due to many secondary, chemical, electrical, and mechanical actions, the general antecedent to which is the influence of a high temperature below the surface of the earth.

This, then, is all that my limits will permit me to state on this most difficult branch of inquiry. It is to be earnestly desired that the present attempts to awaken interest in mining education will be followed by success, and that such topics as the above may receive careful attention, and be illustrated by an accumulation of well-attested and recorded facts.

DESIGN AND BENEVOLENCE IN THE ARRANGEMENT AND RELATIVE QUANTITIES OF METALLIC ORES.

Some remarks on this topic may be naturally introduced here, and, if I mistake not, a decided addition to our arguments in

* *See* Somerville's Connexion of the Physical Sciences, 7th ed. p. 364.

natural theology for Creative Goodness, can be derived from this probably unexpected quarter.

Scarcely any geologist, or intelligent reader, will doubt that nearly every part of the earth's crust, and also its interior, have been, at some period, in a melted or fluid state. This being acknowledged, as the metals and their ores are usually heavier than other rocks, we might have expected that they would have accumulated at the centre of the globe, and have been enveloped by the rocks, so as to have been for ever inaccessible to man; and the presumed great weight of the central parts of the earth, almost twice that of granite, naturally leads to the conclusion that the heavier metals may be accumulated there. This is, of course, a mere conjecture, and open to the apparent objections, that at the depth of thirty-four miles air would be so condensed, by the pressure of the superincumbent mass, as to be as heavy as water; and water, at the depth of 362 miles, would become as heavy as quicksilver; and at the centre, steel would be compressed into one-fourth, and stone into one-eighth of its bulk on the surface. Still, it is most probable that the materials naturally the heaviest would first seek the centre.

Nevertheless, by some of the secret agencies mentioned in the above theoretical views of the origin and formation of mineral veins, whether by sublimation, and expansion by internal heat, or, more probably, by the segregating power of electric action; enough of the metals is protruded towards the surface, and diffused through the rocks in beds or veins, to suffice for the wants of man, and in such a manner as to be accessible to human industry. So, in my previous volume on Coal, I have endeavoured to show how coal has been laid up in the earth, in a form and position the most advantageous for man at this time. I have said that an accumulation of coal may be called a bonded warehouse of fuel, or an unfailing bank of bituminous bullion, readily convertible into currency of one ton, one chaldron, or one hundred-weight, for the uses of all sorts and conditions of men. Were it not for this benevolent arrangement, to speak of little things, the writer would be unable to hold his pen at this moment. But a good coal fire mitigates the severity of the

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winter, and yet how few are led from the fire to muse on the mine, its contents, and the modes of their deposition!

Although mineral masses do not, like coal, contain traces of their origin, in the impressions of plants and vegetable remains imbedded in them; yet even minerals point to the condition of the earth in primeval periods, and in periods very long prior to those connected with the coal formation. As in coal, so in minerals, had all been spread over the surface of the earth, as in the case of peat and wood at present, then a too easy access would have enabled our ancestors to delve, and clear away the greater portion of the metallic treasures. In Cornwall, for example, the wild Britons would have bartered away most of the tin and copper, and in the north of England most of the lead. This exhaustion, going on progressively, would have led to a time when the English might have possessed but a very small supply of metals in their own country.

As it now is, however, the peculiar position of mineral veins is the cause of their preservation, and of their yield of ores in proportion to the wants and the industry of man. Two great ends are evidently answered by the existing arrangements. Successive generations are successively supplied, and ingenuity and industry are increasingly stimulated. There was enough tin for the "old men," as the Cornish call the ancient workers of mines, and they obtained it with facility, having the first run, as it were, on the metallic bank. In their rude state, had the veins been previously much worked, they would have obtained little or no metal, having no machinery or inventive genius. But when, however, the most accessible portions had been worked, then the talent of man must devise some method of coping with the difficulty of deepening mines and fugitive veins.

Soon rude machinery gives place to more effective, and lastly, when water-wheels are found scarcely equal to mining demands, atmospheric engines are introduced. These are succeeded by the wonderful steam-engines of Watt; and still deepening mines, extending works, and accumulating difficulties, lead to the improvement of the steam-engine, until it becomes that beautifully perfect machine which is now at work at the Cornish mines.

The character of the preceding remarks on the phenomena of mineral veins in relation to their natural condition, will further show how the observing and reasoning faculties of the mind must necessarily be called into exercise in mining science. The very complexities of the phenomena are useful in developing the powers of mind of those who have to deal with them; and accordingly we find that the Cornish mining captains are on the whole an intelligent body of men, and well up to mining practice and knowledge. Indeed, I am disposed to think, although the idea may be deemed fanciful, that upon a comparison of various classes of miners in this country, the intelligence of any class will be found directly proportionate to the perplexity of the minerals to be mined. Thus, I believe that the captains of Cornwall, and the chief underground workmen, would stand highest. Next might come the lead miners of the north of Derbyshire, &c.; then the coal and iron miners, who have to deal with fewer perplexities, and whose minerals lie in beds and large uniform masses. Such a result might naturally be expected to occur, and would only be in accordance with results in other departments of human industry. Of course, individual instances of ability or dulness would not invalidate this inference.

To turn to the relative quantities of metallic ores. If I mistake not, there is, as an American geologist observes, such a relation between the amount of useful metals and the wants of society, as could have resulted only from divine benevolence. The metal most widely diffused, and the only one occurring in nearly all the rock formations, from the oldest to the newest, is iron. That, too, is the metal most useful to civilized society, and is the one in most urgent and lasting demand for all kinds of purposes, and for all classes. In addition to its abundance, it may be mentioned that, at least in this country, iron is a metal easily extracted from the earth. Deep and far extending mines, like those of tin and copper, are unknown to iron (as mined alone) in Great Britain; for it principally lies within easy reach, and is interstratified with the coal, which is necessary to melt it, and the limestone, which forms its flux in the process of melting. Iron often forms extensive beds upon the surface, and sometimes

even mountainous masses. There is a mountain in the Ural which is almost a mass of magnetic iron ore, putting one in mind of the fabulous mountain of adamant in the Arabian Nights' Entertainments, which drew out the nails and iron in the sailor's ship as it approached the magnetic mass.

The other metals are confined almost exclusively to the older rocks. Among them, lead, copper, tin, and zinc are, probably, most required, and accordingly they are next in abundance, and in the facility with which they may be obtained. Metals, such as manganese, mercury, chrome, antimony, arsenic, cobalt, and bismuth, are more rare and more difficult to procure, but the supply is always equal to the demand. In the case of silver, platinum, and gold, we find some interesting properties in them, to compensate in some measure for their scarcity.

Gold and platinum possess a remarkable power of resisting those powerful agencies of chemical change which destroy every thing else. They are never oxidized in the earth, and, with a very few exceptions, the most powerful re-agents have left them untouched, while platinum will scarcely yield to the most powerful heat of the furnace. Gold, silver, and tin, are capable of astonishing extension, whereby they may be spread over the more abundant metals to protect and ornament them; and, since the discovery of the galvanic mode of accomplishing this, we conceive that it may be carried out to a great extent in future.

From these statements, it might seem possible to construct a scale of the metals, whereon should be numbered their relative degrees of abundance, and then to apply to it another scale, whereon should be marked the degrees of demand for the metals respectively; and it would then probably be found that the degrees of supply and demand would nearly coincide. Surely no candid observer would fail to recognize in such facts, the benevolent design of the Author of all good, and the Giver of every good and perfect gift!

It is also striking to reflect from what a small *space* of the earth's bulk and mass our metals are derived. The comparative smallness of the largest fissure to the bulk of the whole earth, is

wonderful. In the finest pottery we can make, we may, by means of a magnifying glass, discover numerous cracks and fissures, so small as to be impenetrable by any fluid. But these finest fissures are immensely larger in proportion to the size of the piece of pottery, than the mineral vein to the mass of the whole earth. Yet in these marvellously small veins are stored up amounts of metals not yet half exhausted, and possibly not to be exhausted even when the world is finally destroyed.

The peculiar beauty of inspired testimony to the divine Goodness in providing metals for man to extract from the earth, is lost, owing to the defective rendering of the early verses in Job, chap. xxviii. When more accurately and rhythmically rendered, they would read thus :—

> Truly there is a mine for the silver,
> And a place for the gold so fine :
> Iron is dug up from the earth,
> And the earth pours forth its copper.
> Man digs into darkness,
> And explores to the utmost bound
> The stones of dimness and death shade ;
> He breaks up the veins from the matrice,
> Which, unthought of, and underfoot,
> Are drawn forth to gleam among mankind.
> The surface pours forth bread,
> But the subterranean winds a fiery region.
> Its stones are the sapphire's bed,
> And it hides the dust of gold.
> It is a path which the eagle knows not,
> Nor has the eye of the vulture scann'd it;
> The lion's whelp hath not track'd it,
> Nor the ravening lion pounced on it.
> The miner thrusts his hand on the sparry ore,
> And overturns the mountains by their roots;
> He cuts a channel through the rock,
> And espies each precious gem ;
> He binds up the oozing waters,
> And darts a radiance through the gloom.

Independently of its divine origin, the above is the earliest and one of the most poetical descriptions of mining extant. Moreover, it indicates that mining, to some extent, was practised in the remotest periods.

MINING DISCOVERY.—THE DIVINING ROD.

Mining discovery has always been an interesting subject. I should scarcely have thought the divining rod, or the *dowsing rod*, as the Cornish call it, worth attention, were it not that I find a belief in it still prevalent amongst some old miners in Cornwall; and, strange as it may seem, I find in a recent work on Mesmerism, by an eminent professor, that the phenomena of the divining rod are treated as real, and as a part of the science of animal magnetism. The subject is curious, even if the whole be illusive or imaginary. This I do not say it is—let the reader judge for himself from the following notices.

The *virgula divinatoria*, or divining rod, has been in frequent use, and often mentioned since the eleventh century. To come down to our own time and country, a Mr. William Cookworthy, of Plymouth, said to be a gentleman of known veracity and great chemical knowledge, gained his first knowledge of this rod from one Captain Ribeira, who deserted from the Spanish service in Queen Anne's reign, and became captain-commandant in the garrison of Plymouth, in which town he satisfied several intelligent persons of the virtues of the rod, by many experiments on pieces of metal laid in the earth, and by an actual discovery of a copper mine near Oakhampton, which was wrought for some years. The captain was of opinion that the only proper rods for this purpose were those cut from the nut or fruit trees, and that the virtue was confined to certain persons, and those but few: but Mr. Pryce,* a writer on Cornish minerals, says that the virtue resides in all persons and in all rods, under certain circumstances. [*Query.*—Would the usher of the black rod find it a divining rod?] "The rod," says he, "is attracted by all the metals, by coals, limestone, and springs of water, in the following order:—1. Gold, 2. Copper, 3. Iron, 4. Silver, 5. Tin, 6. Lead, 7. Coals, 8. Limestone and springs of water."

One method of determining the different attractions of the rod may be tried by my reader any where. Stand, holding a

* *See* Pryce's *Mineralogia Cornubiensis*, folio, 1778.

proper rod, with one foot advanced; put a guinea under that foot and a halfpenny under the other, and "the rod will be drawn down towards the face, or backwards to the gold, which proves the gold to have the stronger attraction." The rods formerly used were shoots of one year's growth, that grew forked; but it is found that two separate shoots, tied together with packthread, or other vegetable substance, answer rather better than such as are naturally forked, as the shoots of the latter are seldom of an equal size. Hazel rods cut in the winter, such as are used for fishing-rods, and kept till they are dry, do best.

The manner of holding the rod is difficult to be described. "The small ends, being crooked, are to be held in the hands in a position flat or parallel to the horizon, and the upper part at an elevation, not perpendicular to it, but at an angle of about seventy degrees." The rod being properly held by those with whom it will answer, when the toe of the right foot is within the semi-diameter of the piece of metal, or other subject of the rod, it will be repelled towards the face, and continue to be so while the foot is kept from touching, or being directly over, the subject—in which case it will be sensibly and strongly attracted, and be drawn quite down. The rod should be strongly and steadily grasped; the stronger the grasp the livelier the movement of the rod—its movement is often defeated by want of attention to this. If, too, there be the least jerk or opposition to its attraction, the rod will not move any more till the hands are opened, and a fresh grasp taken. A number of minute cautions of this nature are given, and, if failures occur, people must have been guilty of inattention to the requisites; so, of course, the fault is not in the rod.

My old friend, Dr. Smith, or "Stratum Smith," as he was called—because he was perpetually talking upon strata—told me he had no faith in the divining rod. He, above most men, had opportunities of conversing about it with old miners who professed to believe in it. "Stratum Smith" used to tell with great glee a story of his challenging a diviner to find water, &c., by the rod: the diviner took the rod, and, going over a given

tract of ground, he once or twice had the rod jerked down in due form. Smith had followed the diviner secretly, as he walked solemnly along intent upon his rod, and, wherever the rod was said to show proof, there Smith quietly dropped a stone. After a while, Smith, with a careless air, begged the diviner to try the rod again over the same tract of ground. This the man did, and it jerked several times again. Unfortunately for the diviner, Smith showed that the rod had jerked in far different spots than it did the first time, where he had secretly dropped the stones!

One or two remarkable instances of the supposed efficacy of the rod are on record; and a friend of mine assures me that a diviner went over his grounds, near Bath, with a rod, and that the rod (which was a forked twig cut out of a hedge) actually reversed itself at certain spots, even when my friend held one of the forks: no researches, however, were made in the earth to test the accuracy of the trial. I find that some learned men believed in this science, called rabdology. George Agricola, the able and learned German metallurgist of the sixteenth century, and two other learned men of later date, have written upon the rod, but say the Evil One was in it—anciently a common, though far from satisfactory, way of accounting for wonders. Richelet, in his dictionary (Art. *Baguette Divinatoire*), confesses that, after what he has seen, he cannot entertain any doubt as to the rod's possessing wonderful qualities. Others might be named; but I will only further refer to Bayle, who, in his dictionary, in the notes to the article *Abaris*, gives some curious facts, with reflections which are well worth reading. I have, too, some idea that I saw something put down to the credit of the divining rod in Baron Reichenbach's recent and well-known book on magnetism. I have little space for any thing possibly imaginary or deceptive; there may be more connection between rods and lads than rods and lodes! If turning and talking tables and rapping spirits would but take to discovering mineral veins, we should have less reason to doubt them, and more reason to bless them. The discovery of one tin or copper lode, would be worth a thousand confused and useless communications from any inhabitant of any of the seven spheres.

But some recent circumstances have given a new interest to the divining rod. Professor Faraday in England, and Plücher in Germany, have made several remarkable discoveries in magnetism and dia-magnetism; by which we learn that magnetic properties of a decided kind are possessed by almost all kinds of substances—wet and dry, organic and mineral, animal and vegetable, living and dead. Baron Reichenbach, too, has written a singular work on magnetic subjects, and has propounded strange theories and experiments respecting what he terms the *Od* force, and certain emanations of *Odyle.* Then, again, Mr. Colquhoun and Dr. Gregory have published on mesmeric matters—the latter referring to the divining rod. In his book, *On the Truths contained in Popular Superstitions,* Dr. Herbert Mayo states his own experiences and his own opinion of the divining rod. In 1829, the Comte de Tristan published a large number of facts supporting the theory. In 1847, Dr. Mayo, being in Nassau, thought the locality favourable for testing the theory, and experimented by employing a tall, thin, pale youth, who " had not made five steps (with a proper rod in his hand) when the point of the divining fork began to ascend —the fork had soon described a complete circle, and then it described another." When, in 1851, Dr. Mayo again tried the lad, who had grown in health and strength during the four years, the desired result could scarcely be produced at all. I state the facts thus briefly, and leave the reader to his reflections on these deflections.

Wonders are recently told of the rod as used by Charles Adams, a labourer. Here are the rules for any one who would try his hand:—Go to a hedge, and cut from it a forked twig of hazel or white-thorn, of one or two years' growth; cut off the small sprouts, then place the end of each fork between the *second* and *third* fingers of each hand, and apply your hands closely to each side of the body, just below the short ribs; keep the rod in a horizontal position, and walk slowly over the ground. If you possess the power, when you arrive over the hidden object of search, the fork or rod will either be repelled with force back against the chest, or attracted downwards

towards the earth. Rods of iron and copper wire have been tried with success, the copper being the better.

MANAGEMENT AND WORKING OF A MINE.

The owners of the soil must first be arranged with; if under the ancient stannary laws, then on special conditions; if not, then the lord of the soil grants a *sett* (the mining term), or portion of mining soil, for a lease of years, as twenty-one, with a reserved power of putting an end to the lease upon bad working of the mine. The lord obtains at the termination of the lease all the shafts, levels, timbers, &c., of the mine, in good condition. He demands a rent (royalty) either in ore, or (as now usual) in money. A ratio of one-fifteenth may represent the average amount of the lord's dues. He gets his dues with no trouble—his land is cut up, but he has compensation, and reserved remedy if the mine be very poor; if rich, he may gain an income of a thousand a year or more as dues for one acre of land. The principal terms of agreement determine the extent of ground within which operations may be carried on, and the proportion of the gross mineral produce, or its equivalent in money, which the owner is to receive, free of all expense in raising and rendering it marketable. Often compensation for damage done to the surface is included, with other stipulations local and customary.

Mines are now seldom or ever worked by one person alone; for experience has shown that a company is best adapted for carrying on the operations—the amount of capital being large and uncertain, the risk great, and the time long before adequate returns may be made. The persons composing a company are termed, appropriately enough, the adventurers. Shares are created, which they take up. In the older adventures the shares were commonly either sixty-four or one hundred and twenty-eight in number, in each mine; but of late years the shares have materially varied in numbers. In the great Consols mines the shares amount to 100, and the old number is seldom adopted in modern concerns. Mines are either worked on the "Cost-book system," by statutes having reference to Devon and Cornwall, and founded upon their customs, or as ordinary com-

panies. The cost-book system will be explained under the head of "Mining as a pecuniary speculation."

The adventurers are either resident in the country or elsewhere—sometimes many of them will be resident in distant towns, and often in London. If the mine be a scrip concern, there are directors. The practical direction of the mining work is confided to agents, termed captains, who are generally selected from the most intelligent workmen. The captains, again, form two classes—the underground and the "grass captains;" the latter being engaged chiefly on the surface works, or "at grass," as the surface is termed in Cornwall. One captain of the greatest experience usually governs the rest; and he, in conjunction with one or more of the partners, or with some person appointed as principal manager, attends to all the business of the mine. The departments of accounts, construction and care of engines, purchases of stores and necessaries, ore dressing and surface works, &c. &c., are confided to persons appointed by the manager and principal captain. These one or two superior officers bear the weight of responsibility; and the subordinate captains, whether at grass or underground, are all accountable to them. As a whole, the captains are a very valuable body of men, possessed of a large amount of practical knowledge, and much relied upon by the adventurers. It is noticeable that, latterly, speculators and sharebrokers are anxious to establish communications with the most experienced Cornish captains.

The "purser," who is the chief financial mining officer, is also appropriately named, as he keeps the purse and all the accounts, and receives and pays all money. He is the principal officer in the generality of mines—in older concerns he was commonly one of the adventurers, and was chosen by the rest, and so he is also frequently at present.

At the meetings of the shareholders or adventurers, which takes place at intervals of one, two, or three months, the purser presents an account of the general state of affairs at the mine, and produces accounts. At these meetings the best modes of working the mine are considered, and each adventurer may vote in proportion to his shares—the majority of votes always carrying the question or proposal. Such is the mode of transacting

affairs in mines of established character, and where the shares are not very numerous. In scrip mines, shareholders appoint some party or parties to represent them, as directors or otherwise, and the purser reports to them; in such cases the affairs of the company may be made known to the large body of scripholders in London, or some city or town where the company has been formed. At such meetings calls are made, if money is needed; and profits are divided, if there are any to divide.

OPENING AND WORKING UPON THE VEIN.

The form and arrangement of a mine depends in a great measure on the nature of the mineral deposit to be excavated. In working a mineral vein, as in a copper or tin mine, the excavations will be formed either *vertically*, in a highly inclined position, and pursued *laterally*, or, as the miner terms it, "upon the course of the vein," while the advanced points tend progressively downwards, or in depth. This is the reverse of the mode of working a coal seam, or horizontal mineral bed, like most of those of iron in this country. In the coal mine the principal excavations are formed horizontally around the bottom of the shaft, by which access is first obtained to the deposit.—(*See* "Our Coal Fields," p. 130.)

A few explanations of the principal terms will be useful at the outset. In the technical language of mining, pits open to the surface are called *shafts;* those not open to the surface, but sunk from one gallery to another, are called (in Cornwall) *winzes;* horizontal galleries excavated in mineral veins are *levels*, and similar galleries in rocks (not veins) are *cross-cuts*. The principal gallery, or tunnel, through which the drainage of the mine is conveyed, is termed the *adit*, or *adit-level*—all excavations made horizontally are designated *drivings*, those directed downwards *sinkings*, and those upwards *risings*.

Before commencing operations it is essential to ascertain the bearing or direction of the vein, or lode, and also its dip or underlie—that is, the angle of inclination which the lode makes with the plane of the horizon. These things may be ascertained by sinking a few shallow pits upon the lode, and, when the required information is obtained, the vein may be explored

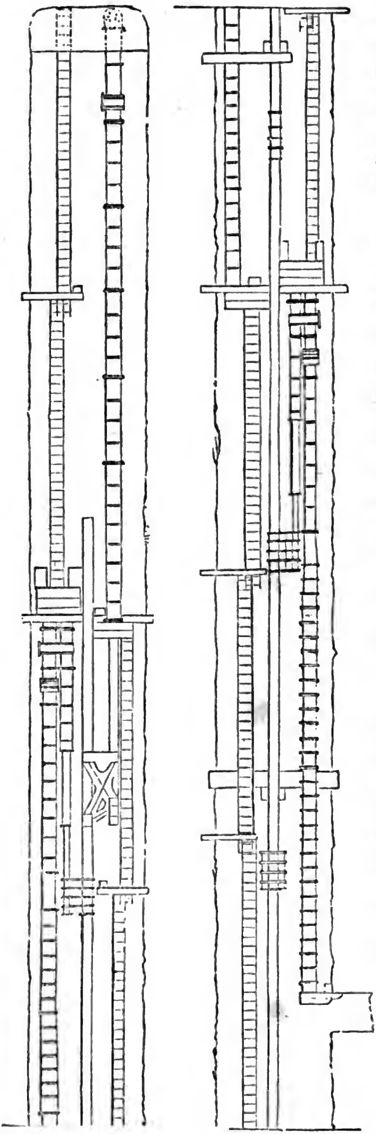
either by sinking upon its course from the surface, or by forming a horizontal passage to intersect it, commencing from some neighbouring valley, or the lowest convenient point on the surface. The former method is generally adopted—a spot being determined for the shaft, it is frequently sunk in an inclined direction upon the course of the vein; or, if intended to be perpendicular, it is commenced upon that side towards which the vein inclines or underlies, and at such a distance upon its "back," as to come down upon it at a given depth, say ten, twenty, or thirty fathoms.

In a verbal description of a mine, it is impossible to detail each process separately and completely at once, because the operations are very much connected, and many are prosecuted together. I must, therefore, be forgiven for partial repetition, and for anticipation of some operations, in order to complete one part of my description. Thus let me, for the moment, go through with the shaft, and then return to the upper portion of it.

After cutting the vein, there are two modes of proceeding with the shaft, either continuing it perpendicularly through the vein, or obliquely upon it. The former, though more expensive and tedious, will perhaps be ultimately the most advantageous. The process is generally, in Cornwall, extremely slow, owing to the great hardness of the ground, and one fathom, or six feet, per week, is not thought very poor progress. Suppose, however, the whole work completed (which, of course, involves the progress of other operations of mining), and you will have ore.

A drainage shaft is shown in two sections, p. 140, exhibiting the upper and lower portion of the shaft of one of the deepest copper mines in Cornwall—with the position of the ladders for the workmen to descend, and the pumps for raising the water—which, with one lift and one piston, often raise it 150 feet, the main rod giving motion to the pistons of the different lifts of the pumps, and being either impelled by a steam-engine or waterwheel. The pipes are generally of iron. I shall speak of steam-engines at the mines presently.

Shafts are commonly sunk of a rectangular form, except in our coal mines, where the form is generally circular. Those intended for the extraction of ores (called "whim-shafts" where horse-whims



are employed for extracting the produce) are usually six feet by four in diameter, and those intended for drainage (called "engine shafts") vary from about six feet by eight, to eight by ten, or more. (In coal mines the shafts are most commonly about seven or eight feet in diameter.) When the depth becomes considerable, many of the first shafts are rendered in a great measure useless, either from their inclined position, or from having passed through the vein at a shallow depth; and thus require long "cross-cuts" previous to commencing the deeper levels. Hence, in very deep mines, a double line of shafts will often be found to range along the course of the principal veins, and sometimes three shafts will be found opposite each other—intersecting the same part of the vein successively at greater depths. In some of the large mines they sink two shafts within a few fathoms of each other; one, the engine shaft, being of large dimensions, and intended for drainage; the other being smaller, and adapted only for a drawing

shaft. This is better than having one large shaft divided by a partition of timber, or, as the coal-miners would say, "bratticed."

To sink shafts in deep mines, so as to cut a lode at the lower levels, is a work of no little skill and labour; but it is mmonly well executed by the Cornish miners. To sink a perpendicular shaft to a depth where it is calculated the lode may be cut, would seem to require little skill; but it must be admitted that great skill is required when, as is sometimes the case, the shaft is sunk in several portions beneath each other at the same time. Then each piece of work, to save time, is commenced at different levels, and must be so accurately worked, that the different pieces may ultimately exactly fit into each other. Several instances are on private record of work thus performed with great precision. These remarks, however, rather apply to mines already in work. Let us return to a commencing mine and its shaft.

When the shaft has been sunk to the depth of about sixty feet, a horizontal gallery or *level* is cut in the lode, say both towards east and west, the ore and materials being raised by a common windlass. As soon as two sets of miners have each cut or driven a level for about one hundred yards, they cannot proceed for want of air. In anticipation of this difficulty, two other sets of miners have been sinking from the surface two other shafts to meet them, and from these the ores and materials may also be raised.

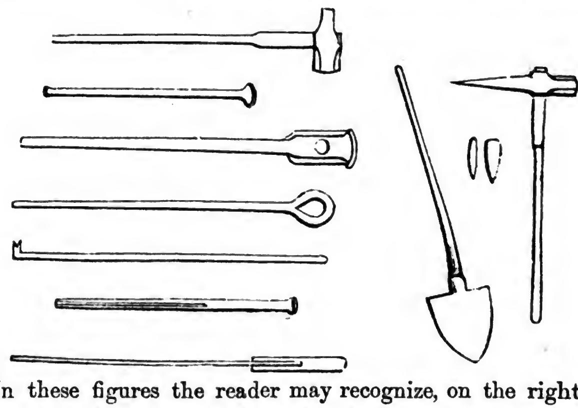
It is evident that by thus sinking shafts a hundred yards from each other, the first gallery or level may be prolonged *ad libitum*. But while this horizontal work is going on, the original or engine shaft is sunk deeper; and at a second depth of sixty feet, a second level, or horizontal gallery is driven east and west, receiving air from the various perpendicular shafts, which are all sunk down so as to meet it. The main, or engine shaft, is then carried deeper still; and at the same distance (ten fathoms, or sixty feet) is driven a third and then a fourth gallery. This may be continued to any depth.

It will be further evident that these shafts and galleries divide the lode into solid rectangular compartments, each of which is, in dimension, three hundred feet in length, by sixty feet in height. These masses of three hundred feet are again

subdivided by small perpendicular shafts into three parts; and by this management the lode is finally divided into masses called *pitches*, each sixty feet in height, by about thirty-three feet in length. In Cornish mines, the sinking of shafts and the driving of levels is paid by *tut*-work or task-work, at so much per fathom. Added to this, the miners receive a small per centage of the ores, to induce them to keep them as separate as possible from the *deads*, or portions of the lode in which there is no ore.

The increase of these shafts and galleries, as above described, tends to shape out a mine as if it were a large upright common window with numerous small panes. The wooden framework of the window, holding panes of glass, would represent the perpendicular and horizontal excavations, the shafts and the galleries, while the panes of glass would stand as the rectangular masses of rock just noticed. The purpose of these excavations is not so much to get immediately at the ores which are produced from them, as to put the lode into a state capable of being worked by a number of men, who are now to take the "pitches."

Before I mention their work, let us examine their tools.



In these figures the reader may recognize, on the right, the miner's pick, his wedges, and his shovel. Ranged under each other successively in the left row, are the blasting or shooting tools of the miner, consisting of his sledge or mallet, his borer, his claying-box, his needle or nail, his scraper, and his tamping bar. He must add to these, powder-horns, tin cartridges, and safety fuse.

SYSTEM OF LABOUR; TRIBUTE AND TUTWORK.

When the lode has been divided, as we have said, it is open to the inspection of all the labouring miners in the county; and, by an admirable system, each mass, or "pitch," is let by public competition for two months, to two, or four, or more miners, who may work it as they choose. These men agree to break the ores, wheel them, raise them to the surface (as they say, "to grass"), and to pay for the whole process of dressing the ores (if desired), and therefore of the expense of bringing them into a fit condition for the market. The ores so raised are sold every week, and the miner immediately receives his *tribute* or per centage for which he agreed to work. This varies from sixpence to thirteen shillings in the pound, according to the richness or poverty of the ore produced. Should the pitch happen to turn out badly, the *tributer* has a right at any time to abandon his bargain, by paying a fine of twenty shillings. Whenever so abandoned, or at the expiration of the lease, the pitches are put up to auction anew, and let for two months more. Some may be getting richer, and some poorer, as the work proceeds, and thus public competition practically determines, from time to time, the proper proportion of produce which the miner should receive. The different pitches seldom turn out to be of similar value; and they are, of course, worked exactly in proportion to their produce. In one the whole vein is worked out, in another only a portion will pay for working, while many will turn out so poor that no one will bid for them. This subterranean lottery abounds in blanks and prizes. Sometimes the lode gets suddenly rich in the pitch, sometimes poor; sometimes it becomes "wrung up," or impoverished; sometimes it heaves, at others altogether vanishes. Tributing, therefore, is a business requiring keen judgment and close application. Two miners often take a pitch together, sometimes father and son, and then relieve each other of work. The wages of tributers on the average will be found in my analysis of Fowey Consols mine. Fifty shillings per month is about the ordinary rate of gain

amongst tributers on the average; but the variations in the value of the work must be considerable. In 1837, the average of tributers' wages was fifty-eight shillings and twopence per month —and of tut-workmen, fifty-three shillings and eightpence.

The mode of payment in tribute and tutwork is wisely made different. In tutwork, or taskwork, where the miner is employed in sinking shafts, driving levels, &c., the object being to extract from him as much useful labour as possible for a given sum, he is paid at so much per fathom. In the case of tributing, where the quality of the ore raised is equally as important as its quantity, the miner receives a certain per centage on the actual value, at the rate of so many shillings in the pound of that value.

The system has been found to work admirably. The owners of the mines, or the adventurers, thus avoid the necessity of looking into the details of so many operations; and yet it is the interest of the tributers to make for them as much gain as possible. While, therefore, the tributers do all they can to enrich themselves, they must, at the same time, enrich the adventurers, unless they defraud their employers. Some miners will steal each other's ores, or, if they come to a very good lode, they will occasionally hide their ore under the rubbish or deads, with the view of making their profits appear inconsiderable, and hoping to be able, at the end of their contract, to take on their pitch for another two months at a low rate. Perhaps they may succeed in this; but sometimes the biter is bit, when he finds that another miner, who has conjectured the plan, has discovered and carried off the hidden treasure.

A common fraudulent attempt is combination between two tributers, one of whom is working very rich and the other very poor ores. The worker of poor ores has perhaps bargained that he is to receive thirteen shillings out of every twenty shillings' worth of ore, while his friend who is working the rich ores is to get one shilling only out of twenty. These two tributers agree to exchange some of their ores in the dark chambers of the mine, and then to divide their gross profits, which are of course very large; for by this management they get, instead of

one shilling, no less than thirteen shillings out of twenty for a portion of the rich ores, while they lose but a trifle on a corresponding portion of the poor ores. As, however, the captains of the mines have been brought up in them, they exercise a rigorous scrutiny into all suspected tricks of this kind.

In most large mines there is a printed set of regulations, to which all the miners working there must subscribe. By these regulations fines are fixed for the non-fulfilment of contracts, which fines are sufficiently heavy to prevent the contracts from being abandoned, while any fair probability exists of their being completed at any reasonable rate of remuneration. Of course, the tributer will not pay a fine of, say, twenty shillings out of mere caprice, and by continuing the work, rather than pay this fine, he sometimes finds the pitch to turn out well. The regulations prescribe other such rules and fines as are found essential for the proper conduct and management of the mine; and, by means of this simple code, the result of mutual and acknowledged interests, it is found that the necessary discipline can be exercised over large bodies of miners.

As each piece of tribute work may require the labour of many individuals, the bargain is taken, and the contract made with one person only. Each gang of men accustomed to work together, selects one of their number to represent and act for them on the day appointed for the "setting" or "survey," when the men assemble round the office of the mine upon a small covered platform, in front of which the agents make their appearance at the appointed time, with a book in which their previous examination has been registered. Every piece of work in the mine is then called out in succession, and accurately defined, and the men make their propositions for working it as above intimated. The captains have previously examined the various parts of the mine, and have determined, to the best of their judgment, the value of the different pitches. The men, on the other hand, have also made an estimate of their chances, and the terms they will offer. The chief captain puts up the various pitches to auction, the biddings decreasing (contrary to what we commonly expect in biddings), from the price he names, which is generally above that which

should be given. So much do the prospects differ, that the tribute may be as low as threepence, and as high as fifteen shillings in the pound. Though the takers of one pitch vary from two to twelve in number, it is usually contrived that there shall be at least two for each "spell" or "core" of eight hours' labour. This partnership is termed *a pair of men*, whatever the number may really be.

The exact time when this system was introduced cannot be precisely ascertained, but it was in force in 1765. One remarkable excellence of this system is, that it prevents strikes, which are unheard of in the Cornish mines. Mr. Babbage has been so interested in the system as to recommend it to general attention. It fosters the virtues of caution, and economy, and forethought in the workman, and prevents jealousy and heartburnings from favouritism and caprice. The tributers are interested in the mine, as they pay something for the use of the fixed machinery for raising the ore, and also for the wages of those who wash and then prepare the ores for sale.

The coarse ores, requiring more dressing, are let out by a separate contract. Each core (corps?) of two or three men, works eight hours, and is then succeeded by another core, especially in the tutwork, which then goes on night and day, as it must be advanced considerably before the tributers can set to work. It can hardly be said that the *tributers* work so regularly, as they have more liberty. They seldom buy or own any of the implements or materials they employ; for these are provided by the company, who charge the miners for the use of them. There is a custom of advancing money to the miners called *subsist*, that they may live until the value of their two months' earnings is determined; and often the women and children working above-ground are paid in the same manner, as the tributers and dressers cannot find means to pay their subordinates as they proceed. I found a similar custom prevailing in the lead mines of the north of England, of which I shall give some examples in a future work. The payments to tributers and tutworkers in particular Cornish mines can be seen in my analysis of the Consolidated Mines, and of the Fowey Consols; but

as the system is so peculiar, and so much admired by some, the following special details may be acceptable. They form a fair example of a tributer's two monthly account at the Devon Great Consols mine, the account being for August and September 1849.

Tribute.—The ore sold for £182 : 2 : 2, and, as the tribute was 7*s.* 6*d.* in the pound, the share for the tributers was £68 : 5 : 9. From this sum the following items were deducted—candles 108lbs, costing £3, 12*s.*; powder 195lbs, costing £6, 10*s.*; safety fusee, £1, 9*s.*; hilts, 1*s.* 9*d.*; cans, 2*s.* 6*d.*; saws, 6*s.*; locks, 1*s.* 6*d.*; smith's costs, £3 : 19 : 6; drawing, £3 : 0 : 11; dressing cost, £6 : 10 : 8; use of grinder, 8*s.* 10*d.*; sampling and weighing, 17*s.* 6*d.*; subsist or money drawn, £36, 18*s.*;—total, £63 : 18 : 2. The men had drawn so largely that they had only £4 : 7 : 7 to receive on pay-day, but the actual costs amounted to £27, or about 40 per cent. on the tribute.

Subjoined is a specimen of tutwork in the same mine, and thereby the two kinds of work may be compared.

Tutwork.—The contract was taken by six tutmen, in November 1849, for as much work as they could do within the month. They were to drive and excavate a horizontal passage or gallery seven feet high by seven feet wide, and were to be paid £7 per fathom for so doing. When the month was out, the quantity excavated was found to be three fathoms three feet four inches, which gave the amount of the earnings £24 : 17 : 9. From this sum the following deductions were made:—48lbs candles, £1, 12*s.*; 50lbs powder, £1 : 13 : 4; safety fusee, 6*s.*; hilts, 3*d*; cans, 2*s.* 6*d.*; smith's costs, £2 : 6 : 10; drawing, £1 : 15 : 6; doctor and sick, 9*s.*; —total, £8 : 5 : 5. These deductions left a balance to be divided amongst the six tutmen of about £2, 16*s.* to each for a month's work.

It is evident that, of the two sets of bargains made by the proprietors, those most easily settled relate to the tutwork and the dressing. The tutworkers, or tutmen, can readily judge of the hardness of the ground to be excavated, and of how much ought to be charged for excavating a fathom of it; while the dressers, who perform the surface work on the coarser ores, can also see before them the kind of material on which their labour

is to be bestowed; but the *tributer* has to a considerable extent to work in the dark, not knowing whether he may be fortunate or unfortunate.

Although the Cornish miners hold a high rank amongst English workpeople for their general conduct, it may be questioned whether this is not rather due to other causes than the excellence of the system of tribute and tutwork. The explanations which I have given of the system of labour and payment amongst the colliers in the north, in my previous book, also show excellence of plan and method; but still the colliers are as often ready to strike as if they were most unfairly dealt with.

DEVELOPMENT AND EXTENSION OF THE MINE.

All the underground work of the Cornish mines, as may be imagined from the preceding explanation, is of two kinds—1. work for discovery or development; and 2. work for extraction and reduction of ores. We might distinguish these two kinds of work as *dead and live work*—the *dead* being that which proceeds in the dead rock, and the *live* that which is concerned in extracting and pulverizing the ores. When it can be managed, the most successful plan of mining is to carry on these two kinds of work simultaneously, and to make the live work subordinate to the dead. It is usual in mines worked on a large scale, and for continuance, not to take out all the ore which could be immediately obtained, but to leave it here and there, to be worked as the general prospects of the mine may require; and to form a sort of reserve fund of ore, to which the miners may have recourse if less is raised in the mine generally than could be desired. The ores thus reserved in various parts are often termed the *eyes* of the mine; and when it may be necessary, from pressing circumstances, to remove them, the process is expressively termed—*picking out the eyes of the mine.* By thus picking out the eyes, and sending them to market, a fictitious value is sometimes imparted to shares—a process analogous to that im-

puted to some joint-stock transactions—namely, paying dividends out of capital.

A good idea of the mode of extending metalliferous mines in Cornwall, will be obtained by a brief inspection of some models in the mining model room of the Geological Museum in Jermyn-street, London. There the contrast between the modes of working coal and copper or tin mines will be seen at a glance; the model of the coal mine being nearly horizontal or flat, and that of the metal mine nearly vertical or upright. There are beautiful models of a Newcastle coal mine, and of Dolcoath mine in Cornwall. For those who cannot visit the Museum, I know no better suggestion than that of two windows, the coal mine being represented in its system of panel work by a window lying flat on the ground, and the copper or tin mine by a window standing upright in the house. Or, if the reader will gaze upon any high stone-built wall, he may suppose the elevation to represent the vertical section of a Cornish mine, the several stones representing the masses of rock containing the lode, the joints indicating the horizontal levels of the mine and the vertical communications, whether shafts or winzes.

A mine, however, does not present so much regularity as might thus be supposed. In mines which are not very prosperous, some of the passages are very low and confined places; though generally in the Cornish and Devonian mines there is ample space for all useful purposes. As the mine proceeds, the section would present a still more irregular appearance. The open spaces whence the ore has been taken vary very considerably, according to the breadth of the lodes, and the amount of ore in them. The lode may be broad, and yet not contain ore enough to be worked. It may be thin and rich in one place, and comparatively poor in another, or the reverse. On the questions of working, the chief agents decide according to their skill and judgment.

Heavy expenses in works of discovery can only be profitably borne by mining establishments of magnitude, which, by sending up a fair general amount of ores, can afford to appropriate a certain proportion of the profits for the expenses of discovery. The Fowey Consols Mine has long been known as a good example

of this character, and expenses are there incurred for discovery which would be ruinous if the mines were divided into three or four separate adventures.

In raising ores, the miners generally work from the "back" or upper part of one level towards the "bottom" of another, and the excavations are so arranged, that the ore may readily fall down to the level below them, whence it is carried in tram-waggons to the shaft, and thence raised to the surface.

The extraction of an extensive mine is very large, though not so large as that of a similarly extensive coal-pit, where nearly the whole of the mass raised is more or less valuable. At the Consolidated Mines, the daily extraction in good times was about 200 tons, a large proportion of which was raised from a depth of from 200 to 300 fathoms (or 1200 to 1800 feet).

The extent to which mines are worked as relates to space, of course depends upon their age and prosperity. Success has perhaps more to do with the extent of excavation than time. A striking example in point is given of the Devon Great Consols mine. When it had been at work only five years, it was found (in 1850) that there were 5853 fathoms, or nearly seven miles of excavation, some vertical, and some horizontal. About a thousand persons were employed, and, in the operations in which they were engaged, they consumed every month above 3000lbs. of gunpowder, and 400 dozen lbs. of candles. There were six water-wheels at work, two for pumping out water, two for drawing up ore, and two for crushing ore. One of the water-wheels is forty feet in diameter, and the water to turn it is brought from a distance of two miles, and, by an ingenious arrangement, the water pumped up from the mines themselves, is made to do duty by assisting to turn this wheel. There are also several steam-engines in this extensive concern.

The extent of excavation in one of the largest and most celebrated mines in Cornwall, viz., the Consolidated Mines, was as follows :—The total amount of sinking, including the winzes, or underground shafts, exceeded twelve miles of perpendicular depth; and the horizontal galleries were, when put together, forty miles in length. These dimensions will appear

remarkable, when the hardness of the rock, and consequent slowness of the progress, are remembered.

Taking a period of twenty years (ending June 1838), Mr. Taylor estimated that about 37,330 fathoms had been *driven* horizontally, and about 18,000 fathoms *sunk* in winzes and shafts, making a total of nearly sixty-three miles!

It will be remembered that there is no light in the mines except that afforded by candles, conveyed by each workman. Each miner has a candle, which is stuck close against the wall of his gallery, by means of a piece of clay. Besides the boys employed in the galleries, there are also boys engaged in wheeling the broken ore, &c., to the shaft, and each of these has a candle affixed to his wheelbarrow by that common mining candlestick, a piece of clay. The men relieve each other every six or eight hours, and continue work (by those reliefs) uninterruptedly, except on Sundays. Notwithstanding this incessant labour, the progress of the miner in excavating his gallery is very slow. One, two, or three feet in a week, or a few inches daily, is often the whole result of the united excavations of twenty or thirty men. In loose lodes, and in killas or clay-slate districts, they perform more; but, as the lode is rarely as wide as the gallery or level, it becomes necessary to cut away the solid rock on each side, which rock is often very hard, even while the lode is somewhat soft. In coal mines the progress is more rapid, because the coal is comparatively soft, and the containing sandstones and shales can be more easily disengaged. The difference of the two is that of working in granite and killas, and working in sandstone and coal partings. Indeed, when you learn the extent of such a mine as Dolcoath copper mine, which is 1800 feet deep, you are astonished at the wonderful industry which, for about a century, has been brought to bear on the hard and immense masses of rock below your feet. The miners there must have been generations of human moles pursuing their slow but certain advances in mysterious candlelight, blind to all the glories and gewgaws of the upper world. While merchants were trading, crossing oceans, and compassing sea and land for gain; while armies were

contending on embattled plains; while kings, and princes, and counsellors were counselling, and plotting, and triumphing, and falling; while ministries and parties were coming in and going out; while politicians were blustering, and mob orators exposing grievances; while the fashionables were trifling life away in balls and routs, and concerts and coquetting; while, in fact, the whole world "at grass," was unconscious of Dolcoath miners, there they were, some two hundred of them (many placed 1800 feet underground), picking and hammering, blasting and breaking, tut-working and tributing, to send up copper for coinage, for tea-urns, for tea-kettles, and for trinkets—and doing all this at the rate only of a few inches' advance daily! Truly, a great Cornish mine is a subterranean monument of human industry and perseverance—a reversed pyramid, with countless chambers and living mummies—an underground palace, or workhouse, or prison, just as you choose to look on the hard dark rock, or the sparkling lode and the glimmering candles!

Most visiters would consider it a prison; for the universal presence of water, soaking through the crevices of the gallery, and intermingling with the dust and rubbish, keeps up a constant succession of dismal and dirty puddles, which literally damp the spirits of those who pass them the first time "for pleasure!"

Gunpowder was first used for blasting in mines in Hungary or Germany about 1620.* It was known in Somersetshire in 1634, after which the Cornish miners became acquainted with it. The annual value of the gunpowder used in blasting in the Cornish mines has been estimated at £13,000, the quantity being about three hundred tons, of two thousand pounds each. In Fowey Consols' annual account, we see the quantity of gunpowder used in one year, in that one mine, was 90,100lbs., or forty-five tons one cwt. in weight, the cost of which in money was £1929, 12*s.*

* In one case in the Harz mountains in Germany, a workman was employed eighty-eight hours in boring a hole four inches deep, during which time two hundred and one boring augers were rehardened, twenty-six remounted with steel, and one hundred and twenty-six entirely destroyed.—Instances of almost equal difficulty may have occurred in England. It is astonishing what progress has been made underground by the employment of gunpowder, especially when compared with the little that could have been effected without it.

This may be placed in a still more striking light (good for gunpowder !) by stating the *monthly* consumption of gunpowder in Huel Vor mine—viz., 3500 lbs.

Not much less costly is the use of candles. In the same mine I find the *monthly* consumption of candles to be 3000 pounds. In Fowey Consols there were used in one *year* thirty-six tons eighteen cwt. of candles (or 6890 dozen), the cost of which was £1777 : 5: 6. The annual cost of coals was about the same—viz., £1770, 13*s.* Finding a great mine in coals and candles is no trifle.

VENTILATION.

But you will say, "How can men breathe so far underground, amidst the smoke of candles, and the smoke of gunpowder, and the consumption of oxygen by their own lungs?" I reply—Breathing is by no means so easy or so pleasant an act down below, as "at grass." You can breathe a vast deal more easily where multitudes of blades of grass are breathing too, than where not a blade of grass is seen. But, as I have already explained, the system of excavation does admit of a certain circulation of air through the framework, as it were, of the mine. Down shafts, along levels, and up and down winzes (ventilating openings), the air is coursing through far too slowly for the poor miner, especially in clearing away smoke. To increase, however, the circulation of air, ventilation of simple but efficient construction is employed in mines. Mr. Taylor has invented a very simple ventilator for mines, in which, upon a cylinder rising, the air from the mine rushes up through a pipe and valve, and when the cylinder descends, this valve shuts, and prevents the return of the air. With a cylinder two feet in diameter, and six feet long, working from two to three strokes per minute, 200 gallons of air may be discharged per minute.*

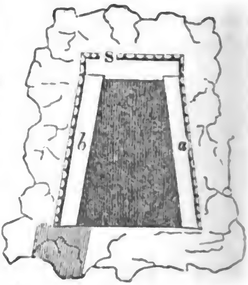
TIMBERING THE MINES.

The *support of the mines* is a matter of necessity, and can only be accomplished by a liberal use of timber. It is evident that, as

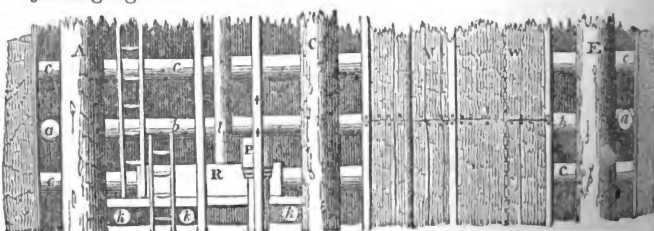
* Mr. Herbert Mackworth has printed a valuable paper on this subject. He found that at the United Mines, a saving of £12 per fathom could be realized by improved ventilation, reducing the temperature from 105° to 75°.

mining proceeds, timber must be brought down and put up. When hollows are increased in the workings, the whole weight of the superincumbent masses has to be upheld. This can only be done by props, and crossings, and supports of timber, fitted in various forms and directions. The quantity of timber in use for propping up, and dividing, and also for descending the mines—in short, for keeping the whole in working order—is enormous. You might imagine that a whole forest of timber is growing under the mining parts of Cornwall, instead of growing on the slopes and mountains of Norway. Norwegian pine is found to be the timber best suited for the purpose.

In a gallery it may be sufficient to support the roof above by means of joists placed across, bearing at their two ends on the rock. Or the roof and two walls may be upheld by means of an upper joist, S, called a cap or cornice beam, resting on two lateral upright posts, or *stanchions, a b*, to which a slight inclination is given. More complicated arrangements are made in particular cases.

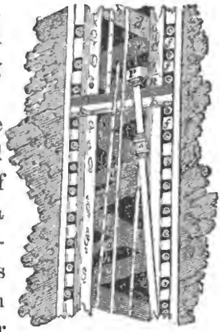


In shafts the timbering is often considerable. The wood-work sometimes consists of rectangular frames, because their shape is more convenient for the miner. The spars of this are placed asunder at distances of from a yard to a yard and a half. This kind of timbering is represented in the adjoining figure :—



That figure represents the vertical section of a shaft, in which we may observe the spaces allotted to the descent of the miners by ladders, to the drainage of the waters by the pump P, and rods *t*, and to the extraction of the mineral substances by the buckets. Various cross timbers are shown by *a*, *b*, *c*, *f*, *h*, *k*, while A, C, E, show the uprights. R is a pump cistern, and V W bucket ways. This shaft is excavated in the line of the vein itself.

The rock enclosing the vein is shown in this figure, which is another vertical section of the same shaft, at right angles to the previous section, with a view of showing the modes of supporting more minutely.



For the total quantity of timber in use for mining purposes in Cornwall, it would require no less than 140 square miles of forest of Norwegian pine, averaging a growth of 120 years. The age of the timber may be inferred by counting the rings in it. In the year 1836,* the consumption of timber for mines was 36,200 loads, or 144,800 trees. The cost of timber imported in the same year was £176,000; the drawback in the duties of which amounted to nearly £82,000. The annual cost for timber in Cornish and Devon mines amounted, in 1834, to £50,947; in 1835, to £64,563; in 1836, to £94,138.

DESCENT AND ASCENT OF THE MINES: MAN MACHINES.

The descent and ascent takes place by ladders, which were formerly nearly perpendicular in the mines, and fifty feet long. But in proportion as the mines have been worked deeper, the ladders have been shortened to about twenty-five feet, and have been placed as slopingly as possible, in order to ease the miner, whose weight is thus rendered more dependent upon his feet, and less upon his hands, than it was before. The distance from step to step in each ladder is from ten to twelve inches. The steps are usually of wood.

* That year was a very speculative one. In 1837, the loads were 14,056, and the cost £36,545.

At the foot of each ladder is a platform called a "sollar," with an opening or man-hole leading to the next ladder beneath, which is generally parallel with the one above. Thus, as soon as a visiter thinks he has got to the bottom of the ladder, and the bottom of the mine at the same time, instantly his guide opens a trapdoor, and discloses another ladder as long as the last—thus, in plain prose, revealing in the darkest deep a lower deep. But perhaps the miner does not descend a quarter of the way down the shaft before he comes to a level, which he must traverse to a winze, or short shaft, which leads him to a level that is beneath that one; and he may even have to traverse some portion of this to a third level. In such cases the ladder-travelling is rendered less fatiguing, by being varied and broken up into short journeys; but it is still fatiguing enough in deep mines to cause the action of the poor miner's heart to be feeble and irregular on his coming to the surface—exhausted by his day's labour and confinement.

At the surface, moreover, he gets into an atmosphere of perhaps thirty or forty degrees Fahrenheit, from a subterranean temperature of eighty degrees, in which he has used great bodily exercise in a most disadvantageous position. You can soon distinguish an old and a young miner by the rate at which they respectively ascend the ladders. The young miner, anxious to get a mouthful of fresh air, and a mouthful of hot tea or coffee, will mount the ladders with speed and exertion, in consequence of which he is much more distressed at the surface than the old and experienced men, who come up slowly, and use as little exertion as possible.

Supposing the depth of the mine to be, as in one instance, 280 fathoms, or 1680 feet, then this extent has to be traversed by ladder-travelling perhaps twice in a day. This will appear more distressing if I use a form of illustration I adopted in speaking of Monkwearmouth coal shaft. The Monument of London piled eight times upon itself would about equal the 1680 feet: imagine a poor miner ascending eight Monuments in succession by slippery ladders, after a hard day's work underground! Some of the mines require the space of one hour to ascend from the depths to "grass."

Do as they will, the fatigue of the miners is excessive, and the waste of flesh, mental energy, and animal spirits is grievous, in addition to the imminent danger of accidents. Now all this daily waste and fatigue are going on without the knowledge or thought of the greater part of our race. It is, then, worth our while to explain and consider the subject a little.

Of course the labour will vary exactly with the depth of each mine. To take an instance in extreme: the shafts alone of one mine, when taken together, compose nearly twenty miles in depth beneath the surface, the perpendicular depth being 1652 feet, or nearly five times the height of St. Paul's from the cross to the ground, which height is 340 feet. Any reader can imagine the enormous labour of a poor miner, who may have daily to descend and ascend some such depths as this, in addition to his day's work and confinement in close places. Some few of the workings, in the old mines of Cornwall, approach, in the manner above estimated, no less than 2000 feet in depth, and these depths can only be reached by ladders, as I have already explained. O thou grumbling clerk in London city, whether a Jones, Smith, or a Davies, whose daily fatigues only extend to the ascent into, and descent from, the trim omnibus that takes you to or from Peckham Rye, or Brixton Hill, or Kennington! Only think for a moment of travelling some four or five times the height of St. Paul's daily—before and after work! O thou querulous socialist, demagogue, or artisan, who canst sit in a comfortable coffee-house, under a flaming gas-light, immediately before and after work—stepping out of the factory or workshop into the coffee-shop — or in your own snug back parlour, by your own fireside and murmuring kettle—do but think for a moment of the Cornish miner, and what he must do before he can reach home or house! I fully believe that the best cure for discontent and gloom, glowering muggishness (if I may coin words), in fortunate workmen, would be to put them upon the treadmill of a deep Cornish mine—for a temporary treadmill it is.

Let us estimate the thing in figures. If you suppose a man to weigh 160 pounds, then in ascending 260 fathoms, which was the depth of the Consolidated Mines twenty years ago (and they

are now 300 fathoms), in ascending 260 fathoms in one hour (below the average computation), the man exerts a constant force equivalent to that required in raising 4160 pounds one foot in a minute, or rather more than one-eighth of a horse power. If you further suppose one-third of this force to be expended in the descent, we arrive at the result, that one-third of his whole physical strength is exhausted in going to, and more in returning from, his work. Taking a fair average of the deep and shallow mines, it is considered to be not far from the truth, that one-fifth of all the muscular power of the Cornish miners is thus expended.

Add to this the injury of the general health, the loss of time, and the recurrence of frequent accidents, by falling off the ladders.

There are equally deep mines in the Harz in Germany. Some of the old Harz mines are 2000 feet deep, and were altogether descended and ascended by ladders until 1833, when an accident suggested a new method. It happened that the pumping apparatus for one of the mines had been rendered unnecessary by the cutting of an adit, and the idea occurred to some inventive German miner of employing the pump rods in aiding the ascent of the miners; the rods being of wood, and seven inches by six, strengthened with iron. The trial was first made with a portion of 100 fathom (600 feet). This was divided into twenty-two portions, and on each portion iron steps were fixed, at intervals of four feet, while hand-holds were fixed at convenient distances. A reciprocating motion of about four feet was given to each rod, and the miners stepped to and fro from a bracket or ledge on one rod to the paralled one on the other. As one rod is always ascending while the other is descending, and *vice versâ*, it is easy to understand how this alternate stepping on to the little platform must lead to the ascent or descent of the miner. At the division between each two of the twenty-two portions, there is a larger platform on which the miner may rest awhile; and nothing is lost by his rest, for the reciprocal motion goes on, and is ready again for his use when he is ready for it. It must be clear that even this one thing is a great advantage over the ladders; for a man could not rest on the round of a ladder—it being the sole province of witches to rest easily on broomsticks.

Moreover, one miner may rest in the large platform while another passes him. On the ladder the man must continue his ascent if another be behind him.

This first attempt proved so acceptable to the Harz miners, that they availed themselves of it eagerly, and a new machine was made in another of the mines in 1836, and a third in 1838. Wood and wire rope were combined ingeniously in these machines. Engineers, miners, and owners, seem to be delighted with these contrivances, one of which descends to the great depth of 2070 feet, more than six times the height of St. Paul's in London!

There is a certain very useful society in Cornwall called the Royal Polytechnic Society of Cornwall, and this society requested Mr. Tregelles, a civil engineer, to prepare plans of the Harz machinery, which he did, and suggested improvements and made estimates of the probable expense. He made it clear how 10,000 miners might, by adopting this machine, save no less than £39,000 per annum in the value of time alone, their chief capital; and this after paying every expense of constructing and working the machinery, and without reckoning any thing for the avoidance of the waste of muscular power, and injury to the general health. Many plans and improvements were suggested, rewarded, and neglected—according to the usual course. At last the owners of the Tresavean Mine announced their readiness to use one of the forms of apparatus to a depth of twenty-four fathoms, and to extend it to the entire depth of 280 fathoms, or 1680 feet, if successful for the twenty-four. The expense of the whole depth was estimated at £1670, towards which the Polytechnic Society agreed to contribute £300 for the first 100 fathoms, and £200 for the second 100, after a trial of two months. The owners of Tresavean accepted this offer, and by the beginning of 1842 they had carried the apparatus to the depth of twenty-seven fathoms, when Sir Charles Lemon and other amateurs descended and ascended thereby, much to their own and every body's satisfaction.*

It was some time before the improvement was extended the

* There is a model of this machine in the Government Museum of Mines, Jermyn-street, London. The steam-engine that works the original is a thirty-six inch double rotatory, acting on two small wheels, and by them on two larger wheels.

whole depth; but in the autumn of 1843, they brought it to the very bottom of the mine. Sir Charles Lemon, as chairman of the committee, then observed in an address:—"Four hundred and sixty miners daily bless the society which projected this scheme, the adventurers who achieved it, and the engineer whose skill has rendered the experiment safe and successful. I hold in my hand a paper of very extraordinary interest: it is a memorial presented to this society, expressing on the part of 391 working miners of Tresavean—whose signatures are affixed—their gratitude for the exertions of this society to relieve them from their hitherto distressing and dangerous toil." Sir Charles then read a simple but grateful letter from the miners. But all persons are most open to pocket arguments, and here came one. The miners saved so much time and strength by the employment of their machine, that they found themselves able to take the work on lower terms than before, and thus they directly benefited the company and themselves. After this, I suppose the old ladders were considered to be ladders of *mis*fortune.

The United Mines Company turned their attention to this improvement, and put up a similar apparatus, improved, in 1845. The apparatus cost £2000; but the engineer of the mine estimated that it would be all paid in two or three years in the saving of miners' time alone. In a report to the society, this engineer, a Captain Francis, observed, "The relief afforded to the miners by this machinery can scarcely be estimated, and can only be fully appreciated by those who, after having nearly their whole strength and spirits exhausted, by working for eight hours, and even longer in some instances, in an atmosphere varying in temperature from 95 to 105 degrees Fahrenheit, had formerly to climb to the surface by ladders. The amount of physical suffering which it alleviates is incalculable; and this benefit would of itself be full compensation for the outlay incurred in its erection; but the advantages which it affords in a pecuniary point of view are equally striking."

Simplifying is the great art and test of improving; and another mining captain, in 1851, supplied a similar and very effective apparatus on the same principle to the Fowey Consols Mine.

This machine extends to a depth of 1680 feet. The rod is eight inches square, with twelve inch platforms at intervals of twelve feet; and there are stationary platforms, equidistant, at the side of the shaft. When a miner is about to descend, he steps on a rod or platform—the rod descends, and carries him down twelve feet; he steps upon a *fixed* platform, while the rod rises again; he then steps upon another moving platform, and descends another space of twelve feet; and so on to the bottom. In ascending, there is simply a reversed process. It is a very interesting sight to witness (especially if you join in) the ascent or descent of bodies of miners at certain hours of the day and night. You see them passing each other in the shaft in a kind of zig-zag course, of as great regularity as any zig-zag will permit. As one miner steps off the rod platform to one fixed platform, another steps on to it from another fixed platform on the other side. Thus there are two streams of miners advancing along the same rod at the same time, one stream ascending and another descending.

In Cornwall, the weekly loss of time sustained by workmen in the ascent and descent of ladders, is estimated at three shillings, and that by the machines at ninepence. These machines are now in very general use in the mines of Belgium, Germany, and France.* Mr. Dieck, inspector of mining machinery in Westphalia, has shown with reference to some foreign mines, that the saving even in money, by the employment of these machines, is considerable. Thus, in a mine where 250 men descend and ascend a shaft of 150 fathoms by the rope system, the saving by the employment of a man machine (even supposing the highest price to be paid for it is £1650) would not only cover this outlay in the first year, but would leave a profit of £693. In a case where the men descend by ladders and ascend by the rope, the saving, by the use of the machine, would cover the outlay for the first year. In one mine having a shaft of 150 fathoms, and employing 250 men, the cost per annum, all the items being reduced to a money value, is as follows:—

Ascent and descent by ladders	£3,150
" " by machines	639

* *See* further Mr. Mackworth's remarks, in p. 28 of the Twenty-first Report of the Cornwall Polytechnic Society, 1853.

Instead of taking the reader down into another mine, I shall here insert a miner's account of her Majesty's visit to a mine, thinking that the interest taken in the descent of the august visiter, and the naïveté of the Cornish narrator, will far exceed any thing we can say of ourselves.

THE QUEEN'S VISIT TO A MINE.

The following is a miner's account of the Queen's visit to Polberro Mine, Cornwall, September, 1846 :—

"I received a letter one evening from Mr. Edmonds, to say as how that Prence Albert was coming to our main the next morning. Thinks I, what can the Prence be a coming to our main for? and I cudn't slape for the night for thinking what I shud say to the Prence, and what the Prence could say to me. Well in the morning, sure 'nuf, we saw the chay coming, and who should be in it but the Queen, so well as the Prence! There was a stone wall between, and the men went to it to't, and was down in a minute—in less than no time, and they come on, and the Queen got out of the chay, and ran about in the wet grass like a Billy! Says she to Mr. Taylor—something, but I don't know what—but says he to me, 'Is it safe for the Queen to go into the main?' 'Safe,' says I; 'yes, safe as the rock of Gibralter!' So the drams were broft footh, and some straw a throw'd into one, and some green baize after it, and the Queen skipt in like a lamb, and I do believe that I touched her She didn't like it tho' when 'twas wet: but when we come on so far as we cud to the west looad, the Prence took the pick and he thravd to like—like a man! and he got a bit a ore This, said he, is from the west looad, so I puts en into my left pocket; and then we went to the east looad, so I puts en into my right pocket; and as they were coming out, says the Queen to Mr. Taylor, says she, 'What's that there blue that I do see?' 'Bliss ye, ma'am,' says he, 'that's the light o' day.' One hundred and twenty miners were ready to cheer 'em as they drove off (all red like Injians, from the red ore of the main) and we did cheer to be sure, as never was before."

A MINE ON THE MOORS.—MUSICAL MINERS AND MINORS.

A very good way of enjoying a visit to a Cornish mine, in some mining districts, is—*not* to start out expressly for it, and to walk straight to it! No, just set out for a long walk on the moors, with provisions for the day, and a shilling or two in your pocket, and you will be in a right state of body and mind for whatever you may discover.

Just try to cross this wild moor here. What a savage-looking scene it is! Here now we have walked at least three miles, and have met nothing but tall blocks and "tors"* of granite. People hereabouts are accustomed to these scenes, and that poor half-starved fellow who is cutting furze or turf yonder, is as much at home by one of these tors as you would be at your own door.

What a terrible thing must a *thunder-storm* be here! Imagine the terrific artillery of heaven pealing over your head; the sharp sleet or rain, driving against and cutting your face; the mad winds beating you down or back; and then, fearfullest of all, the forked lightning leaping from menacing black clouds, and striking on one of these tallest blocks, and then moving with indescribable speed over the stony level; splitting, and cleaving, tearing, blasting, and blackening the oldest and mightiest masses around! Who would dare such a storm here? Who could live in it? Who would not sink in fear, if he beheld a shattered mass of granite, and a pillar of unknown antiquity, split into blasted fragments in one moment of fearful, blazing illumination? Yet I have found, in another place, a man who was once out on such a moor, and in such a scene and storm; but he declared he was afraid of the moor ever afterwards—and well he might be.

Mercifully for us there is no sign or foreboding of storm here now; though you can fancy each split pillar, if you please, to have been the result of one. But let us go on—on—on, over furze, heather, and blocks.

Still mile after mile is only a repetition of this granitic

* *Tors* are rocks which lie piled mass on mass, seemingly in horizontal strata.

savageness. Our voices seem a profanation. Silence is the monarch here; and Desolation the subject. What solitude, what uninhabitable wastes! Surely Providence never meant man to dwell near such places, or build towns and villages within miles of them. Arabian deserts have oases, these have none.

But, hark, there is a Sound! Yes, a curious, unaccountable sound too, somewhere on our right. Let us turn this way. Hollo! here is a rough tramroad—a real rough tramroad over the moor here! Why, there must be spirits here who travel by railway, for nothing of human kind or art is here. Let us follow it. And now that strange sound is increasing upon us,—a noise compounded of clattering and creaking and cranking, and crushing and rushing, and clashing and dipping! What on this earth can it be, and where? Ha! this sudden turn has indeed shown us an unexpected sight. Here is the "grass-work" of a great Copper Mine—all revealed at one turn and glance. Look, look! what a marvellous sight, and what increasingly marvellous sounds. Enormous wheels are slowly and solemnly revolving. High up in the air there are skeleton platforms, and iron chains clanking painfully over iron pulleys. There is a lofty engine chimney, and near it you catch a glimpse of huge machinery, and hear puffs and pulls, and gaspings and groanings, and all corresponding to the alternate movements of big beams of wood starting up into the air and sinking down in dead heaviness. Then here we are at the foot of descending and discoloured streams, evidently polluted by metallic admixture. And somewhere near us flows an unseen but not unheard brook, probably bent on a similar errand, and brought from a similar source for similar work. Now let us rest awhile here. What a congregation of women and children, all engaged in this surface-mining work! And how happy and healthy they look compared with children in coal pits and colliery work! There they sit, "spalling, jigging," "buddling and trunking," and doing all manner of mining mysteries, and delighting in them too. Hark! well, I declare, the whole set are positively singing a hymn, and singing it in parts too! Listen! I never heard it before. Did you? It seems to be a hymn composed for them. Listen again!

O Lord! we mining children raise
  A grateful song to Thee;
Thou wilt accept the feeblest praise
  From all that bend the knee.

Here on this broad and rocky moor
  We utter all our hearts,
And all our supplications pour
  In simple, tuneful parts.

'Twas Thou didst rear these mighty stones
  Ten thousand years ago;
And even then thy chosen ones
  Didst love, and name, and know!

And Thou didst send our Saviour here,
  By whom we're reconciled;
He came to dry the mourner's tear,
  And save the duteous child.

O give us grace to do thy will,
  Whate'er that will may be,
To labour daily, praising still,
  Loving and serving Thee!

Give us each day our daily bread,
  And from temptation keep;
At night preserve us in our bed,
  And send refreshing sleep.

Then will we tread the savage moor
  At morn with thankful hearts,
And all the day thy love adore
  And praise in tuneful parts.

How well the girls take their parts! Farewell ye young vocalists, ye miners and minors!

Again we are on the moor—the mid-moor—amidst tors and pillars rising up tall as the ruins of Grecian temples. How like the remains of some gigantic, primeval Tadmor of the desert! How like the work of an upheaving and shattering earthquake! Nothing is moving now—nothing but the bright filmy clouds above us. What a contrast between sky and earth! Above, all light, luminous, fleecy, airy, and mobile; below, all heavy, dark, scarred, split, and yet sternly motionless. Miles upon miles of motionless masses! Not a single particle of those ten thousand tors in movement. All still, stiff, and silent, as when Druids may have offered sacrifices somewhere in their midst, and as

when aboriginal Britons fought with spear and shield, and danced half-naked or clad in beasts' skins. O ye mighty tors! speak, tell us what you have seen! What a hymn *you* could sing!

THE MOOR BY MOONLIGHT.

Yes, what a hymn you could sing at MOONLIGHT! And how thoroughly have I been led away by a moonlight dream that you *were* singing such a hymn! Standing in the midst of you, in the deep shadow of a tall tor—watching the silvery moonbeams shooting down from heaven, and softly lighting on the large whale-like back of a prostrate pillar—I have felt the charm of the hour, and the charm of the moor, and watched with an eagerness akin to fear, the wondrous metamorphoses the gentle moon has made of you. All your rough, jagged edges, and protruding bosses, and thundersplit needles, were softened down into a dim and undefined smoothness, excepting where the bright, quivering light fell full on the face of one of your loftier companions, and made the deep-scarred features of the giant play with a momentary smile of tenderness.

Yes, the proper time to see a moor dotted over with granite rocks is the moonlight. The mist conceals too much, the thunder-storm is too terrific, the bright day reveals too much; but the moonlight conceals only that which is best hidden, and shows that which is best revealed. It won't do for a prosaic man. He would feel cold and uncomfortable, and be thinking of the warm fireside; but it will do admirably for you and me, reader, who are not satisfied to be always plodding in dingy counting-houses, whose souls are not buried in Russian hides and tallow, or in the price of wheat, or the fattening of stock, or the slaying of pigs, or the cutting up of unlucky authors—it *will* do for us. People make a mistake as to the proper scenes for moonlight views. You don't want ruined abbeys and broken down castles. You want scenes and things more ancient still. A Cornish granite block is of an antiquity to which abbeys and castles are but of yesterday. The moon shone down on them long before

monks and popes were dreamt of; before men came upon the scene at all! Antiquity! Ah! the greatest antiquary is the geologist. Antiquity! Do you desire to see the remains of antiquity? to trace the devourings of the tooth of Time? Come with me on to the old moor. Do you wish to have yourself transported back to the primæval scenes of this earth? Come with me by moonlight to a granite moor—any other moor will not do; I prefer this great and grand Cornish moor, because not far hence are the rich results of incalculable antiquity, in the precious mineral veins which run like silver cords of life under all the huge backbones and ribs of rock that overlie them. Barren enough the whole stricken moor certainly is; but search below, and all around its interior, and there you may find those mineral streams, solid, but shining like sunny water, that will at once banish from your thoughts all idea of barrenness.

Well, it is moonlight after a wintry day, and this is about the middle of the moor; and that is one of the highest blocks, pointing up and glittering beneath the silver flood. Let Imagination have her flight, uncage her, and sit down on the top of this smooth bank, and when you have put away the thoughts and recollections of man's affairs from you, and have familiarized yourself to the scene around you, musing and fancying, then listen—listen to this song of that tall tor yonder:—

THE SONG OF THE GRANITIC GRANDEE.

Ho! Brother Tors! now comes the hour
  When, waking from our stony death,
We feel the moving, mystic power
  That stirs our life, and gives us breath!

What hast thou seen, my brother tall,
  Since last we had a talk together?
Pray, didst thou feel that sudden squall
  Last Monday night?—what horrid weather!

What horrid storms we've had of late!
  I don't believe this thousand years
I've had more snow upon my pate,
  Or trickled down such floods of tears.

I think I've lost an inch of skull,
  Although you know 'tis very hard,
And I in brains am rather dull;
  If storms increase—I'll lose a yard!

I've had some most distressing fears,
  That though I am not made of clay,
Yet in a few such stormy years
  My head will quite be wash'd away!

You know I do not oft complain,
  But now the moon is up on high,
And not a mortal on the plain,
  'Tis safe at least to heave a sigh.

Upon my word, it is not fair
  To keep us here a thousand ages,
Standing bolt upright in the air
  Like Nature's Mutes, or stony Pages,

In stiff attendance on the mountains,
  Who get just thrice our share of sun,
And dash the rains away in fountains,
  Or quickly make them "cut and run."

Ay, run amongst *us* here below,
  As fast as each can other follow,
Until they manage just to flow
  Into some nice, convenient hollow,

Scoop'd out in some short brother's head,
  Not quite so tall as you and I,
And when once in it, as in bed,
  They sleep a month, and softly lie!

Then, amongst other grievous articles,
  There's no such thing as sociality,
Mountains are made of the same particles,
  And yet deny us an equality!

Of many other things beside
  I might complain, but will forbear;
It much, for instance, hurts my pride,
  That cattle should rub off their hair

On right and left, not asking leave,
  Nor having sense enough to see
How such rude conduct can but grieve,
  And compromise our dignity!

How vile that puny Men should dare,
  With hammers big, to strike and chip!—
Just bend a bit, and look down there,
  And mark that blow upon my hip!

I tell ye what, the times are bad
  For us, my granite friends and brothers;
Enough to make us all go mad,
  When so much worse we fare than others.

You'll all remember, I'll engage,
  When I was only just a youth—
About ten thousand years of age,
  (I never utter'd an untruth;)

You all remember what I said
  Before a sign of man appear'd:
We should be left as good as dead,
  And are we not just what I fear'd?

What frolics once we had, I ween,
  When we in earthquakes used to tumble!
But now we stand unmoved, unseen,
  Left to be worn by storms, and crumble.

Then only think of emigration;—
  Thousands are now upon the sea
While I am making this oration;
  If they depart, why should not we?

Why should not we, too, go abroad,
  And strive to better our condition?
Well, I for one, cannot afford
  To stay, at least, in this position.

I've got to keep this tallest station,
  And to maintain a bold appearance
Amongst the nobles of our nation,
  While I should much prefer a clearance.

And then this everlasting rain,
  And these unmitigated storms,
Do my resources deeply drain,
  While keeping up my state and forms.

You all confess that I belong
  To oldest family and race;
Those poor geologists are wrong
  Who give us but a later place.

Somewhere about the time of Adam—
  Why, long before he saw his Eve,
I had been married to my madam;—
  And oh! it makes my soul to grieve,

While dwelling on her mournful fate!
  Myself too much in her I prided,
When lightning struck her on the pate,
  Divorced us, and by death divided!

Still worse—that she who shared my cares
  In this our undisturb'd abode,
Should fall by some surveyor's snares,
  To pieces, just to mend a road!

But let that pass, and let them pass
  Who o'er her bruised remains may walk;
Excuse this dewy tear—alas!
  I fear I've lost my thread of talk.—

Well, now, I recommend a STRIKE!
  We won't continue Mountain Pages;
We must be treated all alike,
  With more respect and better wages.

As I was saying—'tis my notion,
  That we should not be left alone
When all the world is up in motion;
  Why, that's the time for every stone

To rise and stir, and have a dance;
  O! brothers, on this long-dead moor,
If we should once get up and prance,
  And half reveal our wondrous lore,

And tell of half the Druids spoke,
  And the rude Britons in their paint,
Of mistletoe and sacred oak,
  And things that don't become a Saint;

I fancy men would leap from bed,
  And Mormonites would join our meeting;
Then all should see we are not dead,
  Though Time has o'er us long been fleeting.

I fancy cattle would not stay
  To rub their hairy sides on mine;
And, when we footed it away,
  Even men would think us half divine—

Now, brothers, practise on this night!
  Send messages along the moor—
Up, fallen brothers, stand upright!
  Ready with your best foot before!

Up, noblest Tors of ancient race!
  WAKE from your long-enduring sleep;
This is the hour, and this the place,
  Once more in wildest dance to sweep!

Dance as we danced in that old flood,
  When I had all my ninety daughters,
While all these later rocks were mud,
  And we like whales were in the waters!—

Up, Britons, Druids, Victims, Oaks!
  Up, ancient men with chaplets green!
For once astound the Cornish folks,
  For once revive the wondrous scene!

Up, up—revive the old world's dramas,
  Now vanish'd long in ages' sleep,
Before geologists had hammers,
  And miners delved in mines so deep.

Come, old Phœnicians—come, Tin-Dealers:
  From Marazion rise, ye Jews!
Come Smugglers, Wreckers, and Sheep-Stealers,
  Come, tell the ancient county news!

Lo! Britons blocks of tin are wheeling—
  Druids chant a solemn song—
Lo! Jews are hoards of gold concealing—
  Casks of brandy roll along!

Up, my brothers, prance and thunder!
  Start and bolt, and bound and jump!
Cleave the solid ground asunder,
  Rise and romp, and roll and thump!

Make the veins of copper thrill
  Deep beneath us; make the tin
Quiver underneath the hill,
  Down to where the veins begin.———

Ho! brothers, ho! How ye *do* thunder!
  The earth grows young again in you;
Here come the Cornish men in wonder—
  Halt!—this for centuries will do.

Halt, halt!—ye're all gone mad together,
  I do declare my word is vain;
"Ten tons" is dancing like a feather—
  Pre-Adamites are young again!—

Halt! ye dancing Britons, Druids!
  Halt ye prancing blocks of tin,
Casks of brandy, smuggled fluids!—
  Or the moor will tumble in!

Halt! I cry—ye bolting, bounding,
  Jumping, thumping, romping brothers!
All the county round confounding;
  One strike's enough—I'll have no others!

NUMBERS EMPLOYED IN AND ABOUT CORNISH MINES.

On this point it is not practicable to obtain any perfectly satisfactory information at the present period. As the result of much inquiry, I can only state the following estimates. The difference between some of them are such as have occurred from the difficulty of obtaining authentic information, and from the constantly varying numbers of the persons employed in so fluctuating a business as mining. In Mr. Spackman's valuable "Analysis of the Occupations of the People," published in 1827, the following statements are given:—In Cornwall, there are employed in copper mining, 11,639 males and 2098 females; in tin mining there are employed 5706 males and 130 females; in lead mining, 419 males and 21 females; in minerals not specified, 533 males and 27 females; in iron and manganese, a few of both sexes are employed; and, adding together the numbers employed in mining for the whole county of Cornwall, the total is 20,727. This number, I am disposed to think, is under that of the number at present thus employed in the county. To this should be added, for the county of Devon, a total of 1339.

The number of persons working in tin mines, as given by the same analysis for the time, is but small, being for the United Kingdom only 6101. In addition, the manufacture of tin gives employment to 1320 tin manufacturers, and 9657 tin-plate workers, dealers, &c. Authorities in 1847, state the quantity of tin annually produced to be about 4500 tons, which

at £70 per ton, amounts to £315,000, of which the export trade takes about one-third, and the home trade two-thirds.

Turning to the statements in 1842, the number was said to be from 28,000 to 30,000. The number of men, women, and children employed in and about a single mine, varies from a total of only half a dozen to 3000 and upwards. The Consolidated and United Mines employed 1730 men, 869 women, and 597 children—total, 3196. The Fowey Consols employed in 1837, a total of 1706 persons, and in 1836, 1630 persons;* Cook's Kitchen, 247; Huel Prosper, fourteen; and Westcliff Down, six persons. It is not easy to calculate the number of mines; but Sir Charles Lemon has given a list of 160, employing nearly 27,000 persons. Mr. Henwood estimated the total numbers to be—men, 18,472; women, 5764; children, 5764. Another calculation has been made of the number of persons directly and indirectly employed in the tin and copper mines of Cornwall, and it gives 76,000 persons. In the early part of 1854, a Cornish friend estimated the number engaged in mining pursuits to be 28,000, of whom 21,000 were males. More than 3000 males were under fifteen years of age. The whole were distributed over thirty-five parishes, and composed about one-seventh of the whole population.

The subjoined figures show the number of persons employed in two of the largest mines in Cornwall in the year 1836:—

	Consolidated Mines.	United Mines.	Total.
Agents	28	9	37
Tut-workmen	441	198	639
Tributers	392	217	609
Surface men	335	110	445
Boys under ground	109	138	247
Do. at surface	327	23	350
Females	753	114	869
Total	2387	809	3196

* In the analysis of this mine I shall give the details.

† The proportions in a hundred persons in a mine, are said to be about as follows:—thirty tributers, twenty tut-workmen, ten surface labourers, twenty-five boys, and fifteen labourers. They may also be estimated from the analysis of Fowey Consols work-people.

ANALYSIS OF A GREAT MINING ESTABLISHMENT: THE CONSOLIDATED MINES.

As a companion picture to the analysis I gave of a great colliery establishment (*Our Coal and Our Coal Pits*, p. 182), I shall append a view of the Consolidated copper mines, which are the largest in Cornwall, and are easily visited from Redruth, in the parish of Gwennap. This analysis will be complete, and relate to pecuniary matters.

These mines are the result of a consolidation of four other mines into one interest and concern. The workings extend 55,000 fathoms, or sixty-three miles underground, and about two miles long in their works at the surface; and they have made a profit of £700,000.

Previous to consolidation, they returned 17,000 tons of ore per annum, and left a profit of £400,000. Wheal Virgin, now a part of these mines, produced in July and August 1757, in one fortnight, ores which sold for £5700; and in the next three weeks and two days, as much as sold for £9600—the cost of mining the former being only £100, and that of the latter a trifle more in proportion to the quantity. In 1819, a company was formed to work these mines under the management of Mr. John Taylor; but the lease having expired in 1840, they passed to the management of the Messrs. Williams of Scorrier House. During the management of Mr. Taylor, the mines returned upwards of 300,000 tons of ore, yielding £2,000,000. The cost for working them amounted in the twenty-one years to £1,500,000, and about £300,000 profit was divided among the adventurers.

The present proprietors commenced working in June 1840, and from that time to June 1842, they have returned 25,807 tons of ore, yielding £161,120, out of which they divided a profit of £16,500 up to March 1842; but subsequently to that time the mines have not paid expenses. They form on the largest scale an example of mining successes. The United mines afford an example of reverses, just the other way.

In this great concern they have eight large steam-engines,

and about thirty small ones, at work.* The mine is in extreme depth 300 fathoms (1800 feet) deep from the surface, and the cost of working it has averaged about £5000 a month.

The mine is held in one hundred shares, and the machinery was valued at £70,000. Now let us take a special view of particulars.

CONSOLIDATED MINES IN 1836.

	Tons.	Value. £	s.	d.
Quantities of Ores raised... Copper	18,498½	143,039	12	5
Tin		2,533	0	10
Arsenic		144	7	10
		145,717	1	1
Lord's dues on same		6,071	10	6
Amount of ore, deducting dues		139,645	10	7
Total expense for the year		102,007	12	1
Total profit on the mines †		37,637	18	6

DETAILS OF EXPENSES.

	£	s.	d.
Agents, Salaries	3,343	19	0
Tutwork Bargains	26,177	5	8
Bargains on Surface, Wages, Stems, &c.	2,539	8	11
Carpenters, Masons, Smiths, Engineers, &c.	3,099	0	2
Carriage and Horse-work	922	6	6
Materials	15,008	6	4
Engine or Water cost (with rent of Water, £405, 13s.)	15,415	7	4
Expenses on Ores	7,803	8	7
Tribute, Subsist, and Balances	25,030	17	0
Sundry Payments	1,872	3	1
Doctor and Club	795	9	6
	102,007	12	1

NUMBER OF PERSONS EMPLOYED.

Agents	28
Tutwork Men	441
Tributers	392
Surface Men	335
Boys under Ground	109
—— Surface	327
Females	755
Total	2387

* See Details under Steam-Engines at Cornish Mines.

† The loss on the United Mines that same year, was £10,680 : 19 : 2.

RATE OF WAGES, PER MONTH, PAID DURING THE YEAR.

	Month £ s. d.		Month £ s. d.
Tutwork Men	3 11 6	Girls from 14 to 17	0 15 0
Tributers	4 5 0	Girls from 12 to 14	0 12 0
Surface Labourers	2 6 0	Girls from 9 to 12	0 8 0
Women and Girls above 17	0 18 0	Boys above 12	0 13 0
		Boys under 12	0 9 0

The usual rate should be estimated as lower, as in 1836 the demand for miners was great and unusual.

To the above, the *Details of Expenses for Materials and Water cost* may be added, as showing how the total amount, apparently so large, was expended.

Coals	11,817 tons.
Iron of various sizes	108 „
Candles	113,916 lbs.
Gunpowder	64,000 „
Debenture Timber	49,091 feet.
Yellow Pine	2,129 „
Steel of various descriptions	135 cwt.
Tallow	375 „
Flat and round Ropes	977 „
192 hides of Leather	8,996 lbs.
Patent half-inch Chain	3,474 fathoms.
Pick and Shovel Hilts	13,098 dozen.
Nails of various descriptions	91 bags.
Engine Shag and Poldavey	3,438 yards.
Cod Oil	269 gallons.
Rape Oil	727 „
	£ s. d.
Foundery bill for Pumps and Castings	1,735 0 1
Safety-rods used in Blasting	262 10 0
Books and Stationery	50 6 7

From a table of the business of the Consolidated Mines for eighteen years, ending in 1836, I find that from the year 1823 till the year 1836 inclusive, there were raised in all 214,045 tons of ore, and that the total wages paid in connection with that work were £644,699. The highest amount of wages paid in any one of those years was in 1836, when it was £61,257 upon 18,499 tons of ore raised. In the year 1833, the amount of wages was £51,844 on 18,191 tons of ore raised. In 1834, the wages paid were £42,690 upon 20,022 tons of ore raised. Thus it will be seen that no fixed proportion between the two exists.

Nothing can afford a stranger a better idea of the business of a Cornish mine than the above analysis—it brings it before him at once in its magnitude and in its detail. For this reason I add another such an analysis of another large mine in a different mining district—namely, the eastern district.

ANALYSIS OF THE FOWEY CONSOLIDATED COPPER MINES.

These are situated in the eastern mining district, which, not many years ago, was considered scarcely rich enough to repay the labour of mining. Old miners entertained a dominant fancy for the district of Gwennap, and would not depart from it until a few spirited capitalists opened in the eastern district what have proved to be some of the richest mines in the county.

In this district are included the mines of St. Austell, Callington, Liskeard, and Tavistock. The Fowey Consols, as they are called in brief, are situated in the parish of Tywardreath. This one concern consists of four single mines consolidated in one. Three of these commenced working in 1813, and stopped in 1819—the amount expended upon them during that time having been £49,563 : 16 : 11.

J. Treffry, Esq. of Fowey (whose mansion, Place House, I have described) purchased the mines in 1822. In 1836, Lanescot, an adjoining mine, was united with the other three, and the whole consolidated into the Fowey Consols.

Now the concern began to prosper greatly, and, from August 1815 to the end of 1841, these mines returned 234,486 tons, 8 cwt., 2 qrs. of copper, which sold for £1,422,633, 17s.—out of which the profit paid to the adventurers (with a reserve fund not divided) amounted to £179,995 : 11 : 6. The value of the stock on the mines, engines, materials, &c., is from £50,000 to £60,000. There are altogether six steam-engines at work, having a total amount of 302 horse power. There are also seventeen water-wheels at work, of altogether 484 horse power, and there are three hydraulic engines of 119 horse power. Some years ago there were five pump or engine shafts in course of sinking, the deepest being about 200 fathoms below the adit of forty-five

fathoms. Twenty lodes were in course of working, the principal of which run through the sett for nearly two miles. The system of working was chiefly of that kind termed "for discovery," large quantities of ground being constantly opened, and large piles of ore left as a reserve, while operations were carried on in search of more ore.

TOTALS OF FOWEY CONSOLS IN THE YEAR 1849.

	Tons.	Cwt.	Qr.
Quantities of ore raised (copper) in 1857	15,710	12	0
	£	s.	d.
Proceeds for ores sold (including carriage money)	89,083	15	2
Total amount of expenses for the year	73,262	16	3
Amount of profit in the year	15,820	18	1

DETAILS OF THE EXPENSES.

	£	s.	d.
Amount of Agency (including Purser and Clerks)	1,361	3	6
Lord's dish or dues...	4,886	2	11
Smithy, Carpentry, and Sawing	1,701	19	0
Tutwork...	16,347	10	10
Tribute	18,821	7	11
Sundry Surface Labour and Sundries...	3,392	6	5
Charge on Ores (including Carriage, Sampling, and Weighing)	5,956	2	0
Drawing, Filing, and Landing	2,229	19	1
Parochial Rates	292	16	6
Paid to Sick Labourers from Sick Club when unable to work	607	2	1
Paid for Medical Attendance	324	10	5
Rent of Water and Engine Charge (exclusive of Coals) ...	2,247	12	3
Stores in general	15,094	3	5
Total Expenses (as above)	£73,262	16	3

(In 1836, the expenses amounted to £74,960 : 5 : 10.)

DETAILS OF THE STORES.

	WEIGHTS.			AMOUNTS.		
	Tons.	Cwt.	Qrs.	£	s.	d.
Coals	1,888	14	0	1,770	13	4
Iron, various descriptions	106	14	2	1,029	18	4
Steel, ditto	6	18	3	266	0	5
Patent flat and round Ropes	30	7	2	1,074	5	1
Candles (6890 dozen lbs.)	36	18	1	1,777	9	6
Best Russia Tallow (83 cwts.)	4	3	0	189	1	7
Gunpowder (90,100 lbs.)	45	1	0	1,929	12	5
Leather, 43 hides (2393 lbs.)	1	1	2	224	0	4
Patent Iron Chain (590 fathoms)	3	18	3	111	6	1
Nails, 89 bags, various	6	13	2	155	15	11
Foundery Castings, &c.	114	18	2	1,967	11	1

	NUMBERS.	£	s.	d.
Debenture Timber...	59,843 feet	2,766	14	7
Yellow Pine...	997 „	71	16	6
American Oak	835 „	125	9	3
Safety Fuse, 13,802 coils	331,248 „	568	6	8
Pick and Shovel Hilts	811 dozen	86	3	3
Engine Shag and Poldavey	1,119 yards	46	16	1
Cod Oil...	763 gallons	148	7	9
Rape Oil	136 „	49	2	10
Copper Powder Cans		51	10	0
Sieves, Riddles, and Stamp Grates		124	7	3
Account Books and Stationery		75	4	8
Sundries		483	14	11
Total (as above)		£15,094	3	5

DETAILS AND WAGES OF PERSONS EMPLOYED IN 1837.

DESIGNATION.	No.	Av. Monthly Wages. £	s.	d.	REMARKS.	£	s.	d.
Agents, &c. ...	14	6	2	0	8 Agents, 5 Clerks, 1 Storekeeper.			
Engineer ...	1	8	8	0				
Napper and Dialler	1	8	8	0				
Tributers ...	840	3	7	1	Minus deduction of 1s. 9d. for Club and Doctor.*			
Tutworkers ...	358	2	19	2				
Sumpmen ...	52	3	15	10				
Boys underground	15	0	17	6	Blowing air Machines.			
Day labourers ditto	112	2	12	0	Maximum	3	5	0
					Minimum	1	19	0
Day and monthly labourers at the Surface ...	192	2	0	1	Maximum	2	3	4
					Minimum	1	16	10
Boys at Surface	312	1	0	7	Maximum	1	12	6
					Minimum	0	8	8
Women and Girls at Surface ...	309	0	16	3	Maximum	1	3	10
					Minimum	0	8	8
	1,706							

This detailed analysis of one of the most flourishing mining concerns in Cornwall, will enable the reader to grasp the idea of the minute and extended business of the great mines. Few

* Each miner, in these well-managed mines, receives thirty shillings per month during illness, and has medical attendance, with medicine, provided for himself and family. For these allowances, a deduction of one shilling and ninepence is made upon his monthly earnings; the least possible amount to secure such benefits.

would have previously supposed articles of such kinds, and in such quantities, to be required in a copper mine. Who, for instance, would have imagined that thirty-six tons' weight of candles were used in one year in one set of mines, at a cost of £1777? Who, again, would have supposed that nearly £2000 per annum is expended in the one article of gunpowder?

The following were the quantities and prices of the principal materials consumed in the Cornish and Devonian mines in the year 1837:—

			£	s.	d.		TOTALS.
Coals	56,860 tons	at	0	17	0	per ton ...	...£48,331
Timber	14,056 loads	„	2	12	0	per load ...	... 36,545
Gunpowder ...	300 tons	„	44	0	0	per ton ...	... 13,200
Candles	1,344,000 lbs.	„				...	... 35,000

In Pryce's times (1778), the largest copper mines are described as supporting an annual expense of £30,000 for coals, candles, timber, leather, ropes, gunpowder, and various other materials, with the labour of men, women, children, and horses; and also including the lord's dues, which he mentions as generally a sixth, seventh, or eighth part of the whole proceeds in money.*

When Mr. William Phillips, the mineralogist, visited in Cornwall in the year 1800, he stated that the annual expenses of Wheal Alfred (a copper mine) for labour and materials were then about £63,600; and that the number of men, women, and children, amounted to 1500. He also noticed Wheal Crenver, Cook's Kitchen, and Dolcoath, as being the deepest mines in Cornwall at that time—the first being 200 fathoms deep, the second 200 fathoms, and the third 228 fathoms—a fathom contains six feet.

In 1843, the amount expended in mining labour was £900,000, and the annual cost for materials in mining was £300,000.

WATER AND DRAINAGE OF MINES.

Drainage is a principal business at the Cornish mines. The infiltration of the rain and surface waters, together with sub-

* Pryce's *Mineralogia Cornubiensis.* 1778.—Introduction, p. ix.

terranean springs and pools, would soon inundate a mine, and put a stop to the work, were not adequate means employed to drain the mine.

What I have observed in "Our Coal and Our Coal Pits" (pp. 103, &c.), on the feeders met with in coal pits in the North of England, may prepare the reader to learn something of the immense influx of waters in the Cornish mines. Indeed, the greatest amount of actual work at some Cornish mines (as in some collieries) is expended, not on raising the ores, but in raising the waters from the mines.

In some mines a great increase of the quantity of water almost immediately succeeds the commencement of the heavy autumnal rains; in others, on the contrary, this increase, although it is equally certain, does not take place until after an interval of several months. The necessary inference is, that the increase at least is owing to the rain water, which, absorbed by the surface, has found its way into the deeper parts of the mines.

The monthly reports of the *duty* (the weight lifted one foot high during the consumption of a given portion of fuel) performed by the steam-engines, in pumping water out of the mines, as published by Messrs. Lean, under the title of "Lean's Engine Reporter and Advertiser," record the depths of mines, dimensions of the pumps, and number of strokes made by the engines; and thus supply materials for computing the quantity of water drawn out of each mine every month.

An elaborate paper on the quantity of water in the Cornish mines, by Mr. W. Henwood, is to be found in the "Geological Transactions of Cornwall," Vol. V. (1843), p. 413, &c.

One method of drawing off the water from mines on high ground, is to form an *adit*, or horizontal excavation, dug from the bottom of the shaft in a sloping direction to a neighbouring valley. The adit will carry off the water without the aid of machinery, so long as the lowest shaft is above the level of the sea; or an engine may be employed to pump the water into an adit or channel. One of the greatest (if not the greatest) existing works of this kind is called the Great Cornish adit, and extends through the large mining district of Gwennap. It

commences in the valley above Carnon, and receives the branch adits of fifty mines in the parish of Gwennap, forming excavations and ramifications which have an aggregate extent of between thirty and forty miles, and which are in some places 400 feet below the surface of the ground. The longest branch is from Cardrew mine, and is five and a half miles in length. This great adit drains a tract of about 5550 acres in area, and discharges nearly 1500 cubic feet of water per minute. Rather less than one-third of this stream is collected at the adit level, whilst the remainder is pumped up from a mean depth of about 190 fathoms. The temperature of the adit varies between $60^{\circ}\cdot5$ and 68°, and is on an average more than 12° above the mean of the climate. It opens into the sea at Restronget creek, and empties its waters into Falmouth harbour.

A similar great drain is Nent Force Level, in the north of England, draining the numerous mines in Alston Moor. It consists of a stupendous aqueduct, nine feet broad, and in some places from sixteen to twenty feet high. For more than three miles it passes under the course of the river Nent to Nentsbury engine shaft, and is navigated underground by long narrow boats. At the distance of a mile in the interior, daylight is seen at its mouth like a star, and this star is continually enlarging upon you, until you find yourself in open daylight.

Most of the mining adits admit of the passage of men and horses, with rails at the sides for waggons.

THE STEAM-ENGINE AT CORNISH MINES. "DUTY," DETAILS, CHIEF ENGINES.

The steam-engine is the only means of accomplishing drainage in the larger and deeper Cornish mines, where adits cannot be made use of. The history of the greatest improvements in the steam-engine, as applied to pumping and lifting, is intimately associated with Cornwall. It will be seen that it forms an important feature in the mining affairs of the county, when I state that the steam power employed in draining Cornish mines was,

several years ago, no less than equal to 44,000 horses—on the calculation that one-sixth of a bushel of coals performed the work of a horse. Several engines range between 300 and 350 horse power; but as horses must rest, and the engine works incessantly, it would require 1600 horses to perform its work.

The first steam-engine in Cornwall was erected at Huel Vor, a tin mine in Breage, which was at work between 1710 and 1714. This was the kind known as the old Atmospheric engine, which continued in use long after Watt took out his patent; but the superiority of Watt's engine became so apparent, that it gradually advanced in use and fame.

Since Cornwall is without coal, that fuel is enhanced in value by the cost of freight from other parts; and hence the Cornish miners were anxious to extract from coal all possible heating power. The result of all their efforts is, that they get more power out of a bushel of coal in their steam-engines, than do the engineers of other engines and places. Let us now look a little into the course of the improvements in the Cornish engines.

In the year 1778, the engines of Newcomen, which had been gradually much improved, were giving place to Watt's steam-engines. The remuneration required by Watt was one-third of the saving of coals effected by his engines, as compared with the consumption of the old engines. To ascertain this saving a *counter* was invented, which, being attached to the main beam, marked the number of its vibrations, and thus the work done was calculated, and the amount of coal consumed being ascertained, the saving was discovered. The saving of coals by three of Watt's engines erected at Chasewater mine, exceeded £7200 per annum. Though the patent right no longer exists, this mode of calculating the work performed is still in use, and what is termed the *duty* of the engine is estimated by the number of pounds weight (always in millions) lifted one foot high by the consumption of one bushel of coals; the data being the quantity of water discharged from the pumps in a given time, and the quantity of coal consumed in the same time.

In the year 1812-13, Captain Joel Lean suggested the plan of placing a counter on every engine, and of publishing the estimated

duty performed by Cornish engines. This plan having been adopted, the stimulus to improvement became considerable; so that, from a supposed average duty of less than 17,000,000lbs, the duty in 1837 was averaged at 47,087,374lbs.

It is now a very common practice to record the duty of Cornish engines for publication; and for this purpose Captain Lean fixes a counter upon the engines which are to be "reported," that is, to have their duty published once a month. The counter is furnished with a Bramah's lock, the key of which Captain Lean keeps, and by monthly inspection of the engines, and the orders for quantities of coals consumed, the real amount of consumption is ascertained. The "duty-papers" are then made public, and include an account not only of pumping steam-engines, but also of steam used for drawing ores up the shafts, and also for stamping ores in their reduction. The whole particulars are carefully arranged and reported. Thus, you would find the particulars of any engine for any reported year by mere inspection of the duty-papers. For example, I wish to find the duty of Taylor's engine, with cylinder 85 inches in diameter, at the Consolidated Mines, for the half year ending June 1837; and on inspection I observe it to be, 63,020,000 pounds lifted one foot high by the consumption of a bushel of coals. Again, at Wheal Vor, I see that the duty of Borlase's 80 inch cylinder was, for the same period, 74,073,000 pounds lifted, &c. Once more, if I want to find the duty of the engine with a 70 inch cylinder at North Roskear mine, I find it to be for the same period 79,535,000 pounds lifted one foot high, &c.

From a table drawn up by Sir Charles Lemon in 1838, it appears that, since the establishment of duty-papers, the work performed by the ordinary engines has been more than doubled in twenty-four years, and the duty performed by the *best* engines during that time has been more than trebled. Taking the two extremes of that table, we see that in 1813 the average duty of the best engine was 26,400,000lbs lifted; while in 1837 we find the average duty of the best engine to be 87,212,000lbs lifted.

The following tabular view will give the average duty of

steam-engines in Cornwall for four recent years, both as relates to the best engines and to the whole.

Years.	Annual number of Engines reported.	Average Duty of the Engines.	Average Duty of the best Engines.
1839	74	48,880,000	82,292,681
1840	58	49,730,000	81,809,036
1841	51	50,920,000	95,231,522
1842	45	51,620,000	99,262,657

I am enabled to present the following most recent information on steam power employed in Cornwall and Devon.

The total amount in horse power is reported as 5510.

The number of engines at work is reported as being 82.

The average duty (latest reported) is 1500 millions of pounds raised one foot high by consuming one bushel of coals.*

The average quantity of water raised from mines in the counties of Cornwall and Devon, is 9000 imperial gallons per minute.

The following are the largest engines now in use:—

United Mines and Consolidated,	90 inch and 85 inch cylinders.
Poldice,	90 inch cylinder.
Huel Prosper, and Huel Darlington, Godolphin, United Hills, Huel Tor, Fowey Consols, Duffield, and East Huel Crofty,	80 inch cylinders.

A striking illustration of the power of steam, in the same mode of computation, is as follows. The Menai Bridge consists of a mass of iron, not less than four millions of pounds in weight, suspended at a medium height of about 120 feet above the sea. The consumption of seven bushels of coals by the steam-engine would suffice to raise it to the height where it hangs.

The piston of steam-engines is most commonly calculated to

* As reported, but under reality. The duty in 1843 averaged 55,230,000 lbs.; in 1853, it averages 48,000,000 lbs.—refuse coal being now used.

move at the rate of 220 feet per minute, or two and a half miles per hour, a velocity considered most advantageous for a horse. The horse is supposed to be capable of lifting 150lbs over a pulley for eight hours at this rate. Hence a steam pressure of 150lbs, exclusive of engine resistances, on a piston moving at 220 feet per minute, was considered equivalent to a horse-power, though it is usually expressed as 33,000lbs raised one foot high, for convenience in the estimate of steam pressures.

The remarkable attainments of the Cornish engines can only be understood by comparison. The above statements will be surprising when we know that the average duty of steam-engines for other working purposes is believed scarcely to exceed, even if it amounts to, twenty millions.

The reader who has seen some of the wonderful works of the steam-engine in Birmingham or Lancashire, naturally enough supposes that the same kind of engine is found at the Cornish mines, applied to the purpose of pumping. This is quite an error. And the same may be said with reference to engines seen at the coal mines, for instance, of Staffordshire or Lancashire.

The power, the magnitude, and the duty of the Cornish engines, and in many cases their construction, are very different. The worst engines now reported in Cornwall, reach the average duty of Watt's four best engines working there in 1798. These engines are now manufactured in the county. The Hayle Foundery is celebrated for engine-work, and I inspected at that foundery the parts of the enormous engines made for the purpose of draining the great Haarlem lake.

Even to the eye of an observer who is practised in machinery of great magnitude, the first sight and the subsequent examination of such engines is very gratifying. To watch the labour of a giant would be interesting; but to see the giant not only labouring with ease amidst his enormous work, and at the same time at the command of a child, who should be able to stop him at any moment, this would be doubly interesting. Such is the case with the great Cornish engines. The largest of them may be stopped working at any minute by a child of ten or twelve

years of age. Another peculiar feature, too, of these engines is this, that they work with a quietness—or absence of clash and clatter—which is in the inverse ratio of their magnitude. In any of the great Water Works you may inspect the engine, and be half stunned while so doing; but at the Consolidated Mines you are delighted to stand quietly by, while the engine does its duty with ease combined with stillness. The water makes a great rush in the pumps, but the engine itself is calm and comparatively noiseless—like a great mountain reposing in calm greatness, while a perpetual spring brawls at its feet.

Nearly forty years ago, there were very large engines in Cornwall. Some of the cylinders of these engines are ninety inches in diameter. Austen's Fowey Consols is a celebrated engine for duty. It has an eighty inch cylinder, 10·97 load per square inch on the piston, and a length of stroke in the cylinder of 10·31, and in the pump of 9·25; lifting 87,065,000lbs a foot high, by the consumption of only one bushel of coals. It has done greater duty than any other engine in Cornwall. It consumed 84lbs of coal in an hour. Mr. Wicksteed says:—"This is a most splendid engine, and does greater duty than any other engine in Cornwall. The hand-gear is all bright work, and finished in first-rate style."

The greatest quantities of water* discharged from any of the Cornish mines in 1837, was from the Consolidated and United Mines, in the months of February and March, when from the Consolidated Mines were discharged 1657·18 imperial gallons per minute, and from the United Mines 1634·49 imperial gallons were discharged per minute.

Sir C. Lemon ascertained that the whole quantity of water pumped out of the earth by sixty Cornish engines in 1837, attained the amazing aggregate of close upon *thirty-seven millions of tons!* At one mine, Huel Abraham, the enormous quantity of 43,500 hogsheads of water has been pumped up in twenty-four hours, from a depth of 1441 feet.

The machinery employed at the Consolidated and United

* Some have considered these estimates too large.

mines in the year 1835, consisted of eight large steam-engines used in pumping, having cylinders varying from sixty-five to ninety* inches diameter, and added to these was a small engine of thirty inch cylinder employed for the same purpose. Further, eight steam-engines of about twenty inch cylinder were used for drawing ore and other minerals out of the mines. There was also a water-wheel, forty-eight feet in diameter, used for pumping, and another of about forty feet for driving machinery; and also five smaller water-wheels for stamping and grinding ores.

In a notice of the Tresavean copper mine, I furnish the particulars of the great engine there; the total weight of which, when in motion, is 353 tons, sixteen cwt., and the total cost of which, at the mine, was £4185.

The great ninety inch steam-engine on the Consolidated Mines, cost at the foundery £2000, and the pit-work £2000 more. The expense of putting it up was £4000; so that no less than £8000 were expended in its cost and completion with the pit-work. In twenty-four hours it consumed about 180 bushels of coals, which were delivered at 1s. per bushel. It lifted sixty-four gallons of water per stroke, and can work twelve strokes in a minute.

The machinery at the Consolidated Mines was, as we have already seen, valued at £70,000.

The chief peculiarity of the Cornish steam-engines consists in using high pressure steam (of forty or fifty lbs. to the square inch) expansively, by cutting off the communication with the boiler at one-fourth or one-fifth of the stroke; in allowing a short interval between each stroke for the perfect condensation of the steam; and in carefully preventing the radiation of the heat from the boiler, cylinder, &c.

In Davey's engine, at the Consolidated Mines in Gwennap, the cylinder is eighty inch, the stroke eleven one-third feet, and steam of $34\frac{3}{4}$ lbs. pressure is admitted into one-fifth of the cylinder; after which the communication with the boiler is closed, and the steam is worked expansively in the remaining

* A ninety inch cylinder is the largest engine, and the power of such an engine is estimated as equal to three hundred horses.

four-fifths of the cylinder, aided by the nozzle steam, which amounts to about one-ninth of the quantity of steam used in each stroke. The mean pressure in the cylinder has been shown by an indicator to be about nineteen and a-half lbs. per square inch, so that by taking five-sevenths as effective, we should have 4,784,748 lbs. raised one foot high, or 145 horse power. When the engine rises above its usual rate of six strokes per minute to ten strokes, at which it has sometimes worked, its power would be then increased to 240 horse power. The calculated load in the shaft amounts to 13·12 lbs. per square inch on the piston.

The great increase of duty in the pumping steam-engines in Cornwall, principally arises from three causes :—1st. A reduction of pit-work resistances, if not balanced by an increase of water delivery.—2nd. A reduction of engine resistances, conjointly with an increase of power from a given quantity of steam;—and 3rd. An increase of water evaporated (in cubic feet) in the boiler per bushel of coal consumed.

The points or properties of a good mining engine are :—the facility with which the number of strokes per minute can be increased, and also the load in the shaft. The former augments the quantity of water delivered, the latter enables the mine to be deepened without the expense of a new engine. Both Newcomen's and Watt's engines were deficient in this latter respect, owing to the limited increase of load allowable upon the pistons. Hence, as the mine deepened, if it became poor it was abandoned, or, if rich, another engine was erected to work the deeper levels, and relieve the older engine from the excess of its load. The reduction of engine resistances is due to better workmanship, the increased size of the engines themselves, and the less burden on the air pump from steam employed at only one-half or two-thirds of the pressure usual in Watt's engines, when admitted into the condenser after expansion.

A better idea, perhaps, of the machinery and its power than can be formed from the number of pounds lifted one foot high by the consumption of one bushel of coals, may be derived from the following details of the weight and cost of the "pitwork"

(or the parts of the machinery working in the shaft or pit) in the shaft of Davey's engine aforesaid.

PITWORK.	DETAILS.	WEIGHT OF SAME.	
		Tons.	Cwts.
Fixed work..........	Pumps, Windbores, &c.............	161	8
Do. do.	Wood work, about..................	50	0
Moving work	Main Beam...........................	26	0
Do. do.	Pump Rod	40	5
Do. do.	Main Rod..............................	94	15
Do. do.	Four Balances and one Water lift	96	10
Do. do.	Load in the shaft	38	3
		507	1

Cost, according to Prices of 1837.

MATERIALS.	WEIGHTS, &c.		AMOUNT.
	Tons.	Cwts.	£
Wood work...........	117	0	716
Wrought iron	83	17	1575
Cast iron..............	203	14	1969
Brass..................	6	10	976
			£5236

Strong pit work is necessary for the system of working the steam expansively. The following additional particulars of Davey's engine, will be agreeable to all who are interested in the triumphs of the steam-engine.

In thirty days this engine made 269,200 strokes of 8·75 feet each in the shaft, by the consumption of 2859 bushels of coals, or 120 tons per month. Hence each bushel worked the engine for 15·11 minutes on the average, making about ninety-four

strokes per bushel; the load of 85,530lbs. being lifted 823½ feet high, or 70,434,155lbs. one foot high per bushel.

At each stroke, a quantity of water equal to eight and three-quarters feet of a twelve inch pipe, being thirty-three and a half gallons, was delivered at the adit from a depth exceeding 1600 feet; while, in addition, forty-five gallons were delivered at the surface for injection water, and for turning water-wheels. To effect this delivery, a weight of more than three hundred tons is put into motion at each stroke, this weight being balanced, excepting load in shaft.

The main pump rod, which is 290 fathoms long, is formed for about the first 120 fathoms of two twelve-inch square Riga baulk, each from fifty to seventy feet in length. Afterwards the main rod is formed of fifteen inch square baulk, decreasing to fourteen and twelve inch descending; the whole being connected together with iron straps for a distance of one-third of a mile perpendicular, and kept in a proper position during action by forty guides in the shaft.

The particulars of the boilers for this engine are as follows:*—

No. of Boilers	3.	Area of fire surface,	120 square feet.
Length of Do.	37 feet.	Do. flue surface,	2750 do.
Diameter, Outer B....	6½ feet.	Water space, ...	1700 cubic feet.
Do. Inner B....	4½ feet.	Steam space, ...	370 do.

The consumption of steam in this engine is from 500 to 800 cubic feet per minute. Each fireplace has about seventeen feet area, and contains six or seven bushels of coals. The chimneys are constructed about sixty feet high, as a sharp draught is of value in getting up steam rapidly; but the boilers are in most instances sufficiently large to be worked with a slow draught from closed dampers. This practice, and the use of Welsh coal, account for the absence, in general, of smoke from the chimneys of the mines. From the system of "clothing," or covering with bodies which are non-conductors of heat those parts of the engine which may require it, the temperature of a Cornish engine-house seldom exceeds 70° Fahrenheit. Great as is the

* My authority is J. S. Enys, Esq., of Enys, Cornwall, in Sir Henry Delabeche's Report.

usual duty performed by the best Cornish engines, it is commonly far within the limits of steam power, as might be shown by calculation from the elementary fact, that the evaporation of each cubic foot of water, at a pressure of two atmospheres, produces a gross power of 3,800,000lbs. lifted one foot high by the consumption of one bushel of coals.

The steam-engines employed for drainage are erected close to the shaft in which the pumps are fixed, which is called the "engine shaft." One end of the beam hangs over the centre of this shaft, and is attached to the pump rod, which is raised at each stroke of the engine, afterwards sinking with its own weight, which is always counterbalanced by a "balance bob," so that the whole power of the engine is exerted in raising the column of water in the pumps.

The engine is generally enclosed in a large and substantial building, two or three stories high, which affords convenient access to every part of the machinery.

The centre of the beam is supported by the front wall of the house, and a low building attached to it contains the boilers, which in Cornwall, together with the steam pipe and cylinder, are carefully cased and covered up with some non-conducting substances.

Capstan and shears are used in raising and lowering the pit-work, which forms a very important part of the machinery, as above intimated; and which has been much studied and improved in consequence of the great depth of many of the mines, and the vast influx of water in them. The pumps are arranged in "lifts," or columns of considerable height, often indeed from twenty to thirty fathoms, the water being discharged into cisterns placed at the foot of each, and raised entirely by lifting or pressure. The whole column of pumps in a shaft is commonly worked by a single pump-rod, which passes down the middle of it, and communicates with each column by a rod attached to its side.

The steam-engine is of prime importance to the miner, since he cannot choose his localities as the manufacturer can, but must needs follow the mineral treasures. Thus the steam-engine

smokes in the narrow valleys of Cornwall almost at the sea-level, on the verge of the cliff at Botallack, and on the elevated table land of Mexico. Fuel and water alone are wanted for it.

GREATEST DEPTHS OF MINES.

The results of the wonderful improvements of the steam-engine in Cornwall are, that drainage is facilitated, and mines which have been stopped for want of steam power have been materially deepened, and a mass of mineral rendered available which would never have been otherwise reached.

Rather more than twenty years ago, Wheal Abraham Mine had attained a depth of 242 fathoms, or 1452 feet (a fathom being six feet); Dolcoath Mine had reached 235 fathoms; Tresavean copper mine is gradually becoming extraordinarily deep, and it is last reported as being 320 fathoms (1920 feet) deep below the adit level.* The Consolidated Mines are 300 fathoms (1800 feet) deep, and the United Mines 280 fathoms below the adit level. Let the reader realize these depths by imaginary pilings of the highest buildings, as St. Paul's and the Monument, on themselves, a sufficient number of times to attain the respective amounts!

Speaking of mines generally, the Eselschact Mine at Kuttenberg, in Bohemia, now inaccessible, was deeper than any other mine, being no less than 3,778 feet below the surface. Its depth is only 150 feet less than the heights of Vesuvius, and it is eight times greater than the height of the pyramid of Cheops, or the cathedral of Strasburg.

I have fully detailed the wonders of the Monkwearmouth coal mine near Sunderland, in "Our Coal Fields," and therefore I only here repeat that it is probably the deepest perpendicular shaft (in one continuous shaft) in the world.

The bore of the salt-works of Minden, in Prussia, is 2231 feet deep, and 1993 feet below the level of the sea.

* In a recent letter to the author, Robert Were Fox, Esq., F.R.S., says:—"Tresavean is now 2112 feet under the surface, and about 1700 feet below the level of the sea: temperature in deepest level 90° and upwards. Some of the water gushing into the deep level of United Mines has been 106° to 108°."

Mines on high ground may be very deep without extending to the sea level. That of Valenciana, near Guanaxuato in Mexico, is 1686 feet deep; yet it is 5960 feet above the level of the sea, and the mines in the Andes must be much more.

For the same reason the rich mine of Joachimsthal in Bohemia, though 2120 feet deep, has not yet reached the sea level.*

The fire-springs at Tseu-lieu-tsing in China, are 3197 feet deep, but their relative depth to the sea level is unknown.

How insignificant are all the works of man compared with nature! A line, 27,600 feet long, did not reach the bottom of the Atlantic Ocean.

TIN AND TIN MINING IN CORNWALL.—HISTORY AND STANNARY LAWS.

Both Cornwall and Devon possess tin mines, which, however, are most important in the former county. The very earliest notices of our history are connected with reference to tin mines. Herodotus, about 450 years B.C., mentions the tin islands of Britain under the name of the Cassiterides. A mass of interesting antiquarian discussion is associated with the Cassiterides, so called from the Greek word *kassiteros*, *tin* (though some say the word means *pewter*). Diodorus alludes to the Cassiterides, and also gives an account of the tin produced in Britain, saying that "the inhabitants of that extremity of Britain, which is called Bolerion (supposed to be Land's End), both excel in hospitality, and also, by reason of their intercourse with foreign merchants, they are civilized in their mode of life. These prepare the tin, working very skilfully the earth which produces it. The ground is rocky, but it has in it earthy veins, the produce of which is brought down, and melted and purified. Then, when they have cast it into the form of cubes, they carry it to a certain island adjoining to Britain, and called Iktis. During the recess of the tide the intervening space is left dry, and they carry over abundance of tin to this place in their carts; and it is something peculiar that happens to the islands in these parts lying

* Further particulars may be found in note to Humboldt's *Cosmos*, (Bohn's Edit.) p. 148.

between Europe and Britain; for at full tide, the intervening passage being overflowed, they appear islands; but when the sea returns, a large space is left dry, and they are seen as peninsulas. From hence, then, the traders purchase the tin of the natives, and transport it into Gaul, and finally, travelling through Gaul on foot in about thirty days, they bring their burdens on horseback to the mouth of the river Rhone."—*Diodorus*, lib. v.

This very interesting glimpse into the ancient tin trade has set the learned antiquaries to work to determine *Iktis;* but no place on the Cornish coast exactly answers to it except St. Michael's Mount. What a strange scene must the Mount then have exhibited, with the Britons and tin-trading! Imagine yourself on the top of the Mount, and, looking first on the sea, beholding a little fleet of queer vessels making for the Mount —ancient vessels, having beaked prows, or figure-heads of animals or deities projecting forward, painted and bedecked, and having small rough sails flapping against rougher masts. See the vessels somehow guided to the wooden pier, formed of huge rough blocks of trees. Then look to land, and what a far ruder horde of tin traders do you find advancing with weighty loads of the far-sought *kassiteros!* Those tin-sellers are of the same race as the men whom the great Julius Cæsar has described in his Commentaries. Wild fellows they are, with painted bodies, and fierce countenances, and shaggy hair, and a few poor but strong bows, and rude spears, and basket or skin shields. However, rude barbarians as they are, they must be traded with; for tin is not found in Gaul or Italy, and yet the Romans and others must have it. But before you see those beaked prows turned away from St. Michael's Mount, you will behold a battle of business. The Britons and foreign merchants cannot agree as to price or barter. The foreigners want to cheat them. No! Britons will be Britons still—and at last the wily, civilized foreigners are obliged to pacify them, for they cannot set sail without tin. Watch, now, the blocks of tin brought down in little carts that creak beneath their metallic loads. What a howling and shouting there is as these blocks are shipped! What a calling on Jove by the foreigners, and on some strange deity

by the Britons! But at length back come the little carts with packages of metallic utensils and ware, of varied earthenware, of bright beads, and some few prized luxuries. You see the wild Britons tugging these towards their miserable mud hovels, and some of the party begin to quarrel and make fierce gestures before they have divided the spoil. But at last peace is restored. Smoke ascends from holes in the mud huts, and wretched meals are devoured with appetite;—while the rich tin is getting out to sea, and will soon be found in Gaul, and thence brought by long journeys to Germany and Italy! So much for the oldest tin traders. Now descend lower in history to others :—

After the coming in of the Normans, the Earls of Cornwall derived vast revenues from the mines, especially Richard, brother to King Henry III.

In 1201, King John gave a charter to the tin mines of Cornwall, and, in 1305, Edward I. granted them another. England enjoyed an exclusive trade in tin until the thirteenth century, when rich veins of this metal were worked in Misnia and Bohemia about the year 1241. After this, the Germans sold tin so cheap as to materially injure the revenues of Richard, Earl of Cornwall. A charter was obtained with several immunities by his brother Edward. The Stannary laws were also formed by him, and confirmed under his own seal, laying a certain impost upon the tin payable to the Earls of Cornwall.

The Duchy of Cornwall was created in 1337, in favour of Edward the Black Prince, and settled by Act of Parliament on the eldest sons of the sovereigns of England. The mining trade is under the separate jurisdiction of the Stannary Courts. (Stannary is from *stannum*, Latin for *tin*, and hence *stannarius*, of, or belonging to tin.) The Lord-warden of the Stannaries and the Vice-warden are at the head of this jurisdiction, with a final appeal to the Duke of Cornwall and his council. The miners claim to be free from all jurisdiction but that of the Stannary Courts, excepting in cases affecting land, life, or limb. The vice-warden's court is held once a month, and is a court of equity for all matters relating to tin mines and the tin trade. The stannary laws are revised, or new ones enacted by the duke

and his council, with the consent of what is called the stannary parliament, which consists of twenty-four stannators, gentlemen of property in the mining districts, chosen six for each stannary. The last stannary parliament was held at Truro in 1752. An act was passed in the 6th and 7th William IV. cap. 106, entitled, "An act for the better and more expeditious Administration of Justice in the Stannaries of Cornwall," &c. &c. By this act many improvements were made, and the vice-master's court is made a court of record, and is held at Truro.

For a long period in the early history of tin-mining, the mines of Cornwall appear to have been in the hands of the Jews. They became possessors of them chiefly by taking them as securities for loans granted to the early Dukes of Cornwall; and at several periods, when the Jews were hotly persecuted, those engaged in "tinning" were particularly exempted. Many curious remnants of the Jewish rule are met with in Cornwall. Rude furnaces are frequently found beneath the soil of the existing valleys, which are called *Jew houses;* and the tin, which is often found in blocks, formed, as it would seem, by running the melted metal into a rude hollow made in the soil, is called "Jew's house tin." The town of Marazion, opposite to St. Michael's Mount (and supposed to be the ancient port to which the traders from the continent came), is commonly known amongst the Cornish men as Market Jew; and a street in Penzance, leading towards Marazion, formerly had the name of Market Jew-street.

FOREIGN TIN MINES.

Tin ore has been found in few countries in workable quantities. Besides Cornwall, its principal localities are Bohemia and Saxony in Europe; and Malacca and Banca in Asia. One of the richest deposits of tin known is in the province of Tenasserim, on the east side of the Gulf of Martaban, in the Malayan peninsula. The tin deposits occur in several parts of that country; but the richest layer is eight or ten feet thick of sand and gravel, in which masses of tin (oxide) are sometimes found the size of a pigeon's egg. The ores are found also in large caves

near the surface, and, though actively mined for many centuries, there is still easy access to unexhausted portions. Those in the island of Junck-Ceylon sometimes yield 800 tons per annum, which are sold at the rate of £48 to £60 per ton.

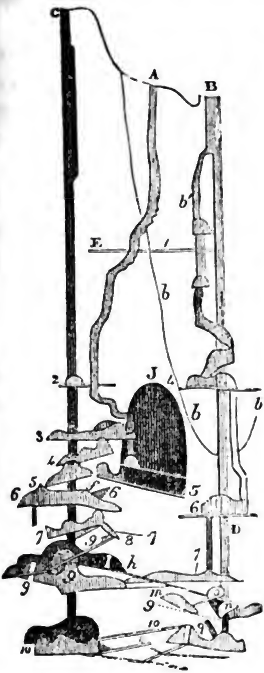
The mines in the island of Banca, to the east of Sumatra, discovered in 1710, are said to have furnished in some years nearly 3500 tons of tin. It is found in the alluvial tracts through every part of the island, rarely more than twenty-five feet below the surface.

Great deposits of tin occur also in the Siberian mining district of Nertshinsk, near the desert of the Great Gobi, and in Bolivia, near Oruro. Small quantities occur in Gallicia, on the borders of Portugal, the department of Haute Vienne in France, and in some mountain chains in Germany.

The tin from Peru and some other countries contains a large amount of tungsten, or wolfram, which very much depreciates its value. Until recently this tin could only be employed for very common purposes, such as making tin pipes, and other articles not requiring tin of good quality. But in analyzing some of this tin, an eminent metallurgist recently discovered a process by which a separation of the wolfram could be easily effected, and this process has been lately patented. It cannot be popularly described; but by it the impure tin, containing from five to ten per cent. of tungsten, and worth, therefore, £25 less per ton than tin of ordinary purity, is so cleansed, that ultimately pure tin is obtained quite as good as the stream tin of Cornwall.

The tin mine of Altenberg, in Saxony, is remarkable for what is termed a *stockwerke*, or interlaced mass of ramifying veins, which has been worked ever since the year 1458. The including rock is a primitive porphyry, superposed upon gneiss. The ore is disseminated in minute particles, and accompanied with wolfram and other minerals. In 1620, the mine was worked by twenty-one independent companies in a most irregular manner, whereby it was damaged to a depth of 170 fathoms by a dreadful downfall of the roofs, which mercifully happened on a Sunday, when the miners were at church.

A sketch of this curious mine is here given, and the depth of he accidental abyss, marked by the curve line *b b b*, is sixty-six fathoms; but the devastation caused by the above accident is manifest to the depth of ninety-five fathoms below that curve, and thirty-five fathoms below the actual workings, represented at the bottom of the shaft under B. The parts excavated are shaded black. There are two masses of ore, one under the shaft B, and another under the shaft C, which at the levels 5 and 10 are in communication, but not at 6 and 7. From 8 to 9 there is a direct descent. The deposits are by no means in one vertical plane, but at a considerable horizontal distance from each other. A is the descending shaft; B is the extraction shaft, near the mouth of which there is a water-wheel; C is another extraction shaft, worked by a water-wheel. F is a drift or gallery for admitting water to drive wheels. At D is a gallery of discharge for the waters. T is a great vaulted excavation. This mine has thirteen stages of galleries, of which eleven serve for extracting the ore.



The mine yields annually 1600 Leipsic quintals of tin, being four-fifths of the whole furnished by the district of Altenberg. To produce this amount of tin metal, 400,000 quintals of ore are raised.

TIN ORES, LODES, STREAM-WORKS, &c.

The tin ores of Cornwall (peroxide of tin) are found in the veins or fissures called *lodes*, and also in *beds*, which furnish strong

evidence of a sweeping inundation having passed over the land, by which rolled pebbles of oxide of tin were deposited below large subsequent accumulations of sand and gravel. The direction of the lodes is mostly from the North of East to the South of West. In this direction they frequently pass through considerable tracts of country, with very few variations as regards their own course. There is always a deflection of the lode from the perpendicular line, which the miners term the *hade*, or the underlying of the vein. Tin veins are considered to be worth working when only three inches wide, provided the ore be good for its width. Some of the mines have very large veins, from which smaller veins diverge. These sometimes cross each other, either horizontally or in their perpendicular descent, when they are called *contras*, or caunter lodes in mining *parlance*. From these causes a mineral vein, without giving any warning, will suddenly utterly disappear. In a single day's working a rich vein of tin may terminate, and leave the miner little clue whereby to find its continuance. A body of clay or other matter appears to interpose, and the search is generally pursued either by working in the direction of the vein, or by sinking a new shaft from the surface; but the result is quite uncertain.

In alluvial beds, or in its dispersed form, tin is called *stream-tin*, and this stream-tin is either met with in a pulverized sandy state, in separate stones called *shodes*, or in a continued course of stones, which are sometimes found together in large numbers, and occur at depths varying from one to fifty feet. This course is called a *stream*, and when it produced a large quantity of the ore it was formerly called *Beauheyl*, which is a Cornish word signifying a *living stream*. In the same figurative style, when the stone was but lightly impregnated with tin, it was said to be *just alive;* when it contained no metal it was called *dead*, and the heaps of rubbish or rubble are now commonly and emphatically called *deads*.

There is no regularity in these tin-streams, as they are of different breadths, though seldom less than a fathom. They are often scattered, though in different quantities, over the whole breadths of the moors, bottoms, or valleys in which they are

ound. As the meeting of rivers makes a flood, so the meeting of tin-streams makes what is called a rich *floor of tin*. He is a happy miner who is thus suddenly *floored!*

The famous *wood-tin*, so called from the woody appearance of some of the pebbles, was formerly found in the Loth stream works in abundance, but these have been washed away in violent storms. It yielded 63 parts in 100 of tin. Wood-tin is much valued by mineral-collectors for cabinets, and recently specimens have been found in the veins of tin.

Stream-tin, or peroxide of tin, being thus disseminated both in the alluvium which covers the gentle slopes of the hills adjoining the rich tin mines, and also in the alluvium which fills the valleys winding round their base, these deposits have given rise to considerable "Stream works" for obtaining the metallic particles and pebbles.

These stream works are conducted by the conveyance of a stream of water over a bed of tin, which, by washing away the lighter matter, leaves the metal to be picked up where the operation has been performed. No doubt this was the most ancient method of tin-getting. But when pits were sunk in those places where the manifest abundance and richness of veins led the miners to penetrate beneath the surface, then the product was raised by being thrown upon successive platforms (called *shammels*), by men arranged at different elevations. Even the rudest form of the windlass was a great improvement on these platforms.

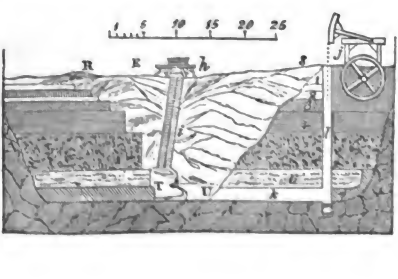
Borlase, in his Natural History of Cornwall (p. 163), mentions stream works as being carried on at St. Stephen's Branel, St. Ewe, St. Blazey, and other places (the most important being those in the valley between St. Austell and the sea) in which tin is still streamed. The Pentuàn works, once so celebrated, are now abandoned. For many centuries have researches for these alluvial deposits of tin been carried on in Cornwall and Devon; so that it is now difficult to obtain sections of unmined ground, except in situations where the tin-stone pebbles are not very abundant. Hence we can form but a poor idea of the great accumulation which must have been formerly worked out by streaming; and consequently we have little conception of the amount

of tin-stone pebbles washed into the bottom of valleys, or into basin-shaped depressions, by the body of water which appears to have passed over the land.

Traces of stream works are to be seen from Dartmoor to the Land's End, and often in depressions on the higher grounds; as, for example, on the former elevated region (whence tin pebbles have long since ceased to be obtained), being the works of the *old men*, as the ancient miners are universally termed in Devon and Cornwall.

Although the richest deposits have been well worked, and the ground turned over probably twice or thrice, the tin stones rejected at one time becoming valuable at another from their comparative scarcity, yet there remains still enough to prevent tin streaming from becoming extinct in Cornwall. The largest works of recent years are carried on at Carnon, near Falmouth. There a long line of stream works extends down the valley, where the tin-ground consists of varying thickness, of rounded masses of tin ore, in some cases unmixed with any other substance, in others formed in a matrix of quartz, and quartz and schorl, with rounded pieces of slate, granite, and quartz, varying in thickness from a few inches to twelve feet. Above this tin-ground lie eight beds of sand, and silt, and shells, in one of which have been found several branches and trunks of trees, some of which had evident marks of being cut with an axe, or other sharp instrument. With these were intermingled horns and bones of stags, and some human skulls.

The Happy Union stream works at Pentuan were till lately very largely worked. As they were interesting, I here present a vertical section of them.



A vast excavation, R, T, U, S, has been hollowed out in the open air, in quest of the alluvial tin ore T, which occurs here at an unusual depth, below the level of the strata, R S. Before

reaching this deposit, several successive layers, viz., 1, 2, 3, were sunk through; the gravel containing about its middle a band of ochreous earth (2) on ferruginous clay. No. 4 is a black peat, perfectly combustible, of a coarse texture, and composed of reeds and woody fibres, converted into a mass by a fine loam. Bed 5 is coarse sea-sand, mingled with marine shells. Bed 6 is a blackish marine mud, filled with shells. Below these the deposit of tin-stone occurs, including fragments of various sizes, of clay-slate, flint-slate, &c. Among these the ore occurs in rounded particles, and the tin-stone commonly in small grains and crystals.

The mining is very simple. The successive beds are visibly cut out into platforms. By a level of efflux *k*, the waters flow into the bottom of the well, *l m*, which contains the drainage pumps. These are put in action by a machine, *j*, moved by a water-wheel. The extraction of the ore is effected by an inclined plane, *i*, cut out of one of the sides of the excavation, at an angle of about forty-five degrees. At the lower end of this sloping pathway there is a place of loading, and at its upper end, *h*, a horse gin, for alternately raising and lowering the two baskets of extraction on the pathway, *i*.

As the density of tin-stone is much greater than that of most other metallic ores in their natural state, it is less apt to run off in the washing, and may therefore be dressed so as to be completely stripped of every matter not chemically combined with it.

DRESSING TIN ORES—VARIOUS PROCESSES.

The processes commence with cleaning and sorting, and then go on to washing and stamping, and finally to calcination in the "burning house," and to smelting. The tin ores of Cornwall and Devonshire are all reduced within the countries where they are mined, as the laws prohibit their exportation. The smelting works, in general, belong to individuals who possess no tin mines, but who purchase, at the cheapest rate, the ore from the pro-

prietors. The ores are appraised according to their contents in metal and its fineness, conditions which are determined by Assay.

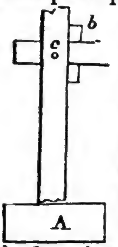
Let us now attend to the dressings:—The object of dressing is to separate, as far as possible, the earthy matter accompanying and often mixed up with the ores. The ruling principles on which all the varied apparatus and processes used in different mines proceed, is this—the difference in specific gravity between earthy and metallic matter, the latter being generally double that of the former.

The dressing-floors of a mine are always arranged as near the mouths of the principal shafts as possible, the ore being conveyed to them by a small railway; and they are always provided with an adequate supply of water by an artificial channel. The floor itself is paved, and there are on one or two sides ranges of sheds for the persons employed to work in, and buildings containing the apparatus used in the operations. These commence by picking the ore, which is brought from the mine in large irregular lumps, as it has been blasted or broken from the vein. Such lumps, of which often more than half is merely spar and veinstone, are broken into smaller pieces with hammers, a labour commonly performed by boys and "maidens," or young women. From rich veins a large proportion of the ore is obtained in a pure state, and then it is only necessary to break down the large irregular masses into fragments of a tolerably equal size to render it fit for the furnace. This rich ore is at once arranged in circular heaps upon the dressing floors, and containing a certain number of tons each—commonly fifteen or twenty—and in this state it has very much the appearance of fine metallic gravel.

The poorer classes of ores, after having been broken by the hammer, and partially separated from the mother rock by picking, have still a great variety of operations to undergo, which depend upon the metal and the quality of the ore itself. Of these processes it will be sufficient for me to notice the principal, and I will illustrate them by brief notices of the processes adopted for tin ores.

1. *Washing and Stamping.*—These processes were conducted as follows at the great works of Polgooth, near St. Austell. The

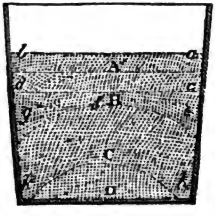
stamps or pestles are of wood, six inches by five and a half in



the square. They carry lifting bars, *b*, secured with a wooden wedge and iron bolt, and they terminate below in a lump of cast iron, A, called the head, weighing about two and a half cwts. A turning shaft communicates motions to the stamps by cams stuck round its circumference, and so arranged that the second falls while the first and third are uplifted. There are four cams on one circumference, and the shaft makes seven turns a minute. Therefore each stamp gives twenty-eight strokes per minute, and falls through a space of seven and a half inches. The stamp chest is open behind, so that the ore slips away under the pestles, by its weight, along the inclined plane with the stream of water. The bottom of the troughs consists of stamped ores. With six batteries of six pestles each, at Poldice, near Redruth, 120 bags of ore are stamped in twelve hours, each bag containing eighteen gallons of 282 cubic inches, measuring altogether 352 cubic feet, and 864 cubic inches.

The openings in the front sides of the troughs are nearly eight inches, and are fitted with an iron frame, closed with sheet iron, pierced with 160 holes in the square inch. The ore, on issuing forth, deposits its *rough* in the first basin, and its *slimes* in the following basins. The rough is washed in *buddles* and *tossing* tubs, the slimes in trunks.

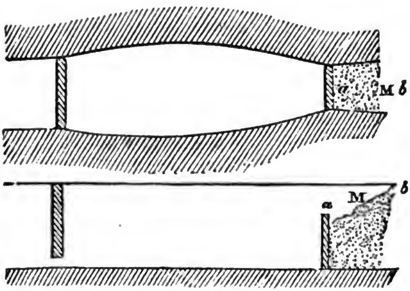
The *tossing* tub or *dolly* is shown in the figure. It receives



the ore with a certain quantity of water, and a workman stirs it about for three or four minutes with an iron shovel. He then removes a little of the water, and strikes the tub on its sides for eight or ten minutes with a hammer, which quickens the subsidence of the denser particles. The water is next poured off by inclining the tub on one side. In one operation of this kind, four distinct strata of the ores may be procured, as indicated in the figure by the lines *a b*, *c d*, *e f g*, *h k*. The portion, A, is to be washed again in trunking boxes

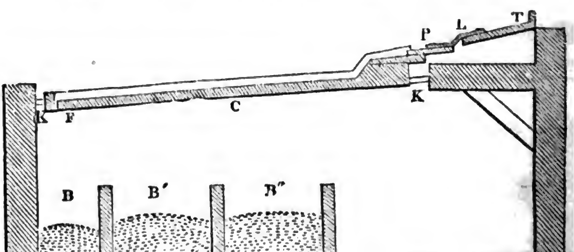
(see next figures), B is to be washed upon the German chest or rack; C, the most considerable portion, is put aside as fit for the market; D, forming a nucleus in the centre of the tub, is to be passed through sieves of copper wire, having eighteen meshes per square inch. This product affords a portion which passes through the sieve, and a portion which remains upon it.

The slimes are freed from the lighter mud in the trunking box.



This box is seven or eight feet long. The matter accumulated at M, is pushed back by a workman with a shovel from *a* towards *b*. The metallic portion is carried off and deposited by the stream of water upon the table; but the earthy matters are floated along into a basin beyond it.

And now we come to another machine. The last product of the trunking box is collected in the chest, and is divided into two portions, one of which is worked once, and the other twice upon the *rack*, as shown in the adjoining figure.



This machine is composed of a frame, E, which carries a sloping board or table, susceptible of being turned round to the right or left upon two pivots, K K. The head of the table is the inclined plane, T. A small board, P, attached by a band of leather,

L, forms the communication with the lower table, C, whose slope is five inches in its length of nine feet. The ore is thrown upon T in small portions of twenty or twenty-five pounds. A woman spreads it with a rake, while a stream of water sweeps a part of it upon the table, where it is washed. The fine mud falls through a cross slit near the lower end, into a basin, B. After working for a few minutes, should the product (called schlich) seem tolerably rich, the operative turns the table round its axis, K K, so as to tumble it into the boxes below. The mud is in B, an impure product in B′, which must be washed again upon the chest or *rack*, while a product fit for roasting is found in B″."

Stream tin is dressed by similar methods: first, by washing in a trunking box of such dimensions that the workman stands upon it in thick boots, and makes a skilful use of the rake by separating the large pebbles from the small purer ones. Then follow the picking, stamping, and washing on a kind of *sleeping table*.

Variations in the above processes are found in some localities, and in the mining works of the Harz in Germany more elaborate machinery is employed; but the principle is the same in all cases. From the preceding description it will be seen, that by repeated pulverization, washing, and agitation, the metallic ores may at length be obtained in a very pure state, the earthy matter with which they were originally intermixed being by these processes almost entirely separated from them.

A branch of metal business is to ascertain by cheap and simple methods, termed *assays*, the quantity of metals contained in the different specimens of ores to be heated. This branch is indeed preliminary to others, and determines the value of any given lode or vein.

Assays ascertain the proportional quantities of ore in a specimen, and therefore proceed beyond the blowpipe. Assaying is divided into—1st, mechanical; 2nd, assaying by the dry way; 3rd, assaying by the humid way, which is not reducible to simple processes, but comprehends true chemical analyses; and an expert chemist is often required to obtain a result that may be

depended upon. Chemical analysis, rightly applied to metallurgy, will certainly produce great improvements. The assayer determines the standard of copper, of which I shall speak in connection with mining speculation.

TIN CLEANING.—OXLAND'S PROCESS.

Tin is often combined with wolfram, tungstate of iron, and other materials injurious to it for commerce. A new process by Mr. Oxland easily separates the wolfram from the tin, and the ore may be thoroughly cleaned by it. It may be strictly described as follows :—

The ore is brought to grass (*i. e.*, to the surface) in an iron waggon, running between four rails, adjusted to the irregular inclination of the sides of the chasm by the power of a steam-engine or a water-wheel. The ore is discharged into another waggon on a horizontal railway, and carried to the dressing-floor, where the large masses are broken or "spalled" to a size suitable for the crusher. The whole is then washed to remove the mud, and after being picked over by "bal-maidens" (girls employed at the mine to remove the waste), the residue is conveyed to the powerful crusher, and is ground down to a coarse powder. From the crusher the ore is taken to the dressing-floors, where, by a series of washings in running streams and in still water, the whole of the earthy matters are almost completely separated. The residue consists of the black tin, associated with iron, copper, and arsenical pyrites, and with wolfram. By the return of the water, this mixture of metallic matter, named *Witts*, (*query*—whether so called because the whole of the metals are then at their *wit's end !*) These witts, all variously named according to their character, are in the next place conveyed to the burning-house, where they are roasted in a large reverbe ratory furnace at a red heat. The black tin and wolfram remain unaffected by this, but other separations are effected.

A series of scientific processes are now brought to bear upon

the ore, and at length the wolfram is expelled, and eventually, instead of being the cause of deteriorating the value of the tin ore, it may be made to produce additional value, by the uses to which it can be by itself applied. This process proves how skilfully man can turn apparent disadvantages in natural products to the best ends.

TIN METAL.

There are now three kinds of tin made in Cornwall—viz., grain tin, refined tin, and common tin. *Grain tin* was formerly made solely in blast-furnaces only from the diluvial tin ores, or what we have explained as being called stream-tin—this being remarkable for its purity.

This was the only kind of tin used for making tin-plates, or rather for tinning the plates of iron; on account partly of its fluidity, and partly of its superior colour and lustre. It was also used in small quantities in dyeing scarlet, and in making tin-foil. Grain tin has of late been almost wholly made in reverberating furnaces, like other tin, but still generally from diluvial ores. The cheaper mode of manufacture has greatly reduced the price. The name *grain tin* is derived from its quality of granulating. This is done by placing a block of it in a furnace kettle, and heating it as high as it will bear without melting. It is then raised by a pulley to a considerable height, and suddenly dropped on a hard surface, by which it becomes instantly divided into small striated masses, to which the name *grain* is given.

Refined tin, though not equal in quality to grain tin, is made from selected ores, and fluid enough for the first coat of iron plates. It is used by most of the tin-plate manufacturers.

Common tin is made from the mass of the tin ore of Cornwall. The term *block-tin* has become disused amongst miners.

The quantity of grain tin employed in dyeing, and in making tin-foil, probably exceeds 200 tons per annum.

Tin is so malleable, that it may be reduced to leaves (tin-foil) only 1-1000th of an inch thick.

SMELTING OF TIN: PRODUCE OF BRITISH TIN.

The ores of tin raised in Cornwall and Devon are always reduced or smelted within those counties, their exportation for such purposes being prohibited. But this prohibition is not injurious to private interests, as the vessels which bring the fuel from Wales for the smelting furnaces, return to Swansea and Neath laden with copper ores. The smelting works, not exceeding seven or eight in number, do not generally belong to the proprietors of the mines, but to other parties, who purchase the ores from them, their value being determined by a kind of assay, of which more will be said under the sales of copper.

The smelting of tin ores is effected by two different methods, which may be briefly described by stating, that by the first and most common, the ore mixed with culm is exposed to heat upon the hearth of a reverberating furnace, in which pit coal is used as fuel; while by the second method, which is applied merely to stream tin, and which is followed in order to obtain tin of the finest quality, the ore is fused in a blast furnace called a "blowing-house," in which wood fuel or charcoal is used.

The blowing-house furnaces are about six feet high from the concave hearth to the throat, or commencement, of the long narrow chimney, which, after proceeding for some distance in an oblique direction, contains a metallic chamber, in which the metallic dust carried off by the blast is deposited. The blast is introduced either from large bellows or cylinders. No substance is added to the ore and charcoal, unless it be the residuary matter of a previous smelting. The proportion of charcoal consumed is about one ton and six-tenths for every ton of tin produced. The melted tin runs off from the furnace into an open basin, whence it runs off into a large vessel, where it is allowed to settle. The scoriæ are skimmed off; and subsequent operations consist of refining, by allowing the mass of the metal to rest, then submitting the upper and pure portion to the refining basin, and remelting the lower part. In order to convert the blocks into *grain tin*, they are heated until they

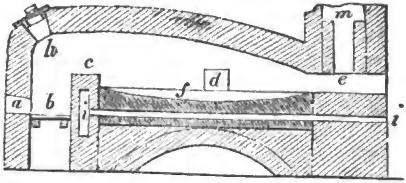
become brittle, and made to fall from a considerable height in a semi-fluid state, thus producing an agglomerated mass of elongated grains.

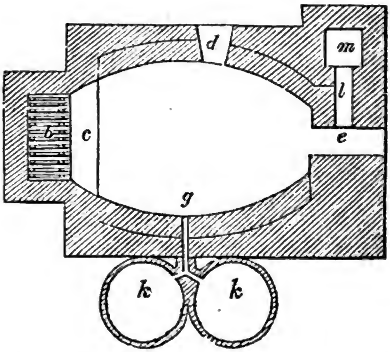
In the other method the prepared ore is mixed with culm, and a flux added. These substances being blended, and a little water added to the mixture to facilitate the operation of charging the furnace, then from twelve to sixteen cwt. of this mixture form the ordinary charge, or in the smelting furnaces of St. Austell from fifteen to twenty-four cwt. The charge is spread upon the concave hearth of the furnace, and then the apertures by which it is inserted are closed and luted. The furnace, being gradually heated, is kept hot for six or eight hours, by which time the reduction of the ore is completed. One of the apertures is then opened, and the melted mass stirred up to complete the separation of the tin from the scoriæ, which are then drawn out by means of an iron rake. These scoriæ consist chiefly of masses of refuse matter, though some pieces are reserved for further processes. The refuse being removed, a channel is opened, by which the melted tin flows from the hearth into a large vessel, called the basin of reception, where it rests for some time, that remaining impurities may separate by specific gravity. When settled, the tin is ladled into moulds, so as to form it into large blocks or ingots. The ingots frequently contain additions which have escaped decomposition, and therefore the process of *refining* must be pursued with them. Refining consists of several processes preliminary to the actual refining, which is effected by plunging billets of green wood into the melted tin in the refining basin. The heat disengages considerable volumes of gas from the wood, and a kind of ebullition is produced in the tin, which causes the lighter impurities to rise to the surface in froth, and the heavier to fall to the bottom.

The largest erection of smelting-houses (containing reverberatory furnaces), in the county of Cornwall, is that called Calinnick, about a mile from Truro: it comprises ten or twelve furnaces, each six feet high, and nearly twelve feet in length. Here culm is used as the fuel, in the proportion of about one-eighth to the ore, of which nearly 600 cwt. is smelted within six hours,

and yields about 350 cwt. of tin. The blowing-houses are near St. Austell, in some of which cylinders are used, and in others huge bellows.

The adjoining figures represent in section and ground-plan smelting furnaces at St. Austell.





The tin is run from the furnaces into basins, as *k k*, and then into moulds, yielding blocks which weigh from two and three-fourth cwts. to three and three-fourth cwts. each. These blocks or pigs, after being coined, are either sold entire, or again recast into small rods to suit foreign markets. If one of these rods be bent backwards and forwards, it yields a singular cracking sound, and at the same time gives out a peculiar odour.

It is not certain when pit-coal first began to be substituted for wood or charcoal in the reverberatory smelting-houses; though the date is thought to be about 1680. An ingenious German,

named Beecher, being much persecuted in his own country, came over to Cornwall, and introduced several improvements in the method of mining, and this of coal amongst others, as the best for fluxing the tin ore. Beecher's own account remains in a sentence of Latin. On the other hand, Pryce, in his account of the mineralogy of Cornwall, attributes this improvement to, amongst others, Sir Bevil Grenville of Stow. Whoever might be the discoverer, in the smelting of tin, as of other metals, the application of this fuel has been of immense advantage.

Tin ore can be brought from the Malay countries, and smelted here and returned to the East cheaper than it can be produced upon the spot.

The following tabular statements present the best accounts that can be obtained of the produce of this metal.

TIN ORE PRODUCED IN BRITAIN.

YEARS.	TONS.
1845	7739
1846	8945
1847	10,072
1848	10,176
1849	10,719
1850	10,383
1851	9455
1852	9674

The mines producing the largest quantity of tin in 1852, in Cornwall and Devon, were Balleswidden, 405 tons, 2 cwts.; Great Polgooth, 355 tons, 10 cwts.; Polberro, 222 tons, 5 cwts.; Drake Wall, 218 tons, 16 cwts.

TIN IMPORTED.			BRITISH TIN EXPORTED.
Years.	Tin.	Tin Ore.	
	Tons.	Tons.	Tons.
1848	298	33	1797
1849	1791	7	1764
1850	1685	...	1588
1851	2387	5	1011
1852	2372	22	941

APPLICATIONS OF TIN IN THE MANUFACTURES AND ARTS.

Tin possesses so many excellent properties, that we should have supposed the people of every age to whom it was known would have employed it in a variety of ways; yet it is a remarkable fact, that vessels of tin have rarely been found amongst Greek or Roman antiquities. Tin recommends itself by its superior silvery colour, its ready fusion, the ease with which it can be hammered and twisted, its lightness, and its durability. It is not soon tarnished; it is still less liable to rust or to oxidize; and it not only retains its splendour a long time, but, when lost, easily recovers it. It is probable that the difficulty of working it rendered it rare in its use amongst the ancients; for the rolling mill, the stamp, and the lathe of the moderns are essential to its successful use. In this country, indeed, the consumption of tin in the manufacture of articles composed exclusively of this metal is very inconsiderable; for the greater portion is used in the state of leaves, or what is called tin-foil. For this purpose the metal is expanded either by means of rolling or hammering, or both combined, until it is scarcely the one-thousandth part of an inch in thickness. Tin is the substance which, covered with a portion of mercury, composes what is called the "silvering" of looking-glasses. The best of the ancient metallic mirrors, or specula, were made of a mixture of tin and copper.

Tin is very important in dyeing processes. Solutions of tin in nitric, muriatic, and other acids, give a degree of permanence and brilliancy to several colours, not to be obtained by the use of other mordants. For this purpose the variety called grain-tin is employed. The moderns have carried to great perfection the application of tin to the coating of other metals. Tinning small wares, and iron plates, form important branches of industry. The latter process is both curious and intricate. It may be found decribed in "Manufactures in Metal" (Cabinet Cyclopædia), Vol. III. p. 36, &c. The last edition is that of 1853, and is much improved by Mr. Robert Hunt.

The chief peculiarity of the manufacture, apart from the rolling of the plates, consists in the remarkable chemical affinity that subsists between tin and iron; so that even cast iron may be tinned in the same manner as wrought iron.

Very many ornamental articles are produced by embossing or stamping tin plate, in the same manner as other metallic sheets, with a fly-press, or other machinery. At Birmingham many cheap coffin-plates are thus manufactured.

Tin forms the principal ingredient in various kinds of pewter and other white metallic alloys, which are manufactured into domestic utensils by casting, stamping, and other processes, in which much ingenuity is displayed. Britannia metal consists of three and a half cwts. of best block tin, twenty-eight lbs. of martial regulus of antimony, eight lbs. of copper, and eight lbs. of brass. The brilliancy, lightness, and cheapness of the numerous wares made from this composition, have secured for them an extensive demand in this and other countries. Every where one may see candlesticks and coffee-biggins, &c., of this material.

COPPER—VARIETIES OF ORES, MINES, AND HISTORY.

The species of copper ores most commonly found, and which alone become of practical importance with us, are—1st, the carbonates of copper, blue and green; 2nd, the sub-sulphuret of copper, or, as it is more popularly named, grey copper ore; 3rd, the ordinary, or yellow copper ore (also a sulphuret), called copper pyrites. This last species forms the material produce of the English and Irish mines. Grey copper is sometimes found very abundantly, and is a very valuable ore; but commonly it is only found in small pieces, mixed with the yellow or ordinary ore. It often consists of eighty per cent. of copper, with twenty of sulphur.

The Cornish copper ores yield an average of from six to eight per cent. of copper; therefore those ores, which contain ten per cent. of marketable copper, are considered rich.* This com-

* Singular masses of native copper have been occasionally discovered. A wonderful specimen of this kind was exhibited in the Crystal Palace from Cornwall, and is now in the hall of the Geological Museum, Jermyn-street.

parative small per centage of the pure metal in the ores, results from the prevalence of useless admixtures. For example, the copper pyrites is almost universally associated with iron pyrites (bi-sulphuret of iron), and every district has generally some characteristic admixtures in combination with the ore. Thus, we see how the average produce of the copper mines scarcely exceeds seven per cent. of pure metal. In Ireland, the average produce of the Ballymurtagh mine in county Wicklow is about four and a half per cent. In the Waterford district we find an average as high as from nine and a half to ten per cent.

Some of my readers have probably visited the lakes of Killarney, and, if so, they will have heard there of the Mucruss copper mines, and those of Ross Island. The Mucruss mine was worked with great profit from the year 1749 to 1754; but, difficulties arising from the European war, it was abandoned. Its site is still pointed out by loquacious guides to the very romantic ruins of Mucruss Abbey. I mention these mines to introduce a curious fact in their history. At the period of their being worked, there was found in great profusion a mineral of a granulated metallic appearance, as hard as stone. Its colour on the surface was dark blue, tending to a beautiful pink.

As it certainly was not copper ore, and possessed no apparent value, it was rejected as cumbersome rubbish. One man alone, and he a workman, had a suspicion of its worth, and he contrived to get away upwards of twenty tons of this rejected rubbish. It was not till long afterwards that it became known to the proprietor of the mine, that this rejected material was an ore of *cobalt*, a mineral of great value, from which the beautiful blue glass and smalt-blue are made.

British copper is chiefly produced from Cornwall, yet very rich mines have been discovered and worked in other parts of our island.

In 1768, the celebrated Parys mountain was worked for copper, and was discovered to be extraordinarily rich in this metal; and, in 1789, these mines were producing annually 3000 tons of that metal. The very streams were so impregnated with copper that it was profitable to precipitate from them.

About the same period, the great Ecton copper mine in Staffordshire was discovered, and its most productive period was about 1780.

There was also a very rich copper mine at Eardiston, near Oswestry, Shropshire, the rock in which it was worked being a red sandstone. The ore is principally the green carbonate, mixed with earthy black ore and red oxide. Some of this ore has yielded a produce of $14\frac{3}{4}$ per cent. of copper. More than £8000 have been expended in the mine, and machinery erected (with an engine) worth £2000. The "sett," or leased space of mining ground, is a mile in length on the course of the lodes.

About ten years ago, a tunnel was completed through the Llandudno mountains in North Wales, leading to some copper works. It was commenced in February, 1834, and was worked by twelve miners, alternately night and day. It is cut in a straight line, measures 874 yards, is six and a half feet high, and has an arched roof. On approaching the boundary of the works, and drilling holes through the rock, the water burst through with great velocity in a stream of not less than 396 gallons per minute, rushing through the tunnel like a cataract. It was computed that by this means a body of water, 198 feet in depth, and of immense breadth was thus discharged.

Pure copper is of a singularly red colour, exceedingly malleable and ductile. When at a red heat, it admits of being hammered, in which respect it differs from brass. As compared with iron, it is remarkably incorrodible, and nearly as tenacious in structure, but not so hard. These and other qualities render copper inestimable to the manufacturer. The quantity consumed in this country is very great, particularly in the sheathing of ship's bottoms, the coinage of money, conversion into brass, and for innumerable purposes of the coppersmith.

That this metal was well known to the ancient nations is commonly admitted. When brass is specifically mentioned in ancient writings as distinct from gold, silver, and iron, it must be often understood as referring to copper either in its pure state, or as alloyed with tin and forming bronze. Such is unquestionably the meaning of the word, as found in our version

of the Holy Scriptures; as, for example, in Deut. viii. 9, "out of whose hills thou mayest dig *brass*." Brass, being a factitious metal, the base of which is always copper, the latter alone must have been the product of Judea. The chief source of the wealth of the Pharaohs was the mines of the neighbouring countries of Nubia and Ethiopia, which were productive of copper in great abundance before iron was known in Africa. The operations in the mines of Nubia were interrupted by the invasions of the Ethiopians, and afterwards by the Medes and Persians. In the passages of the mines were found many tools of bronze, iron being then unknown, and vast masses of human bones of people who had been buried in the mine. The extent of the subterranean galleries is so great, that they must have almost reached to the sea.

The Greeks knew copper very early, and some copper mines are mentioned by Strabo and others.* The Etrurians, according to Macrobius, first obtained copper and afterwards iron. When the boundaries of their city were marked out, they were marked with a ploughshare of copper or bronze. Their priests had their hair cut with knives or razors made of copper. It is also said of them, "These people supplied Rome with the copper from which was coined all the money which circulated in Rome, through several succeeding centuries."

Copper swords, but more frequently *celts*, under which term a variety of cutting and rending tools are included—always cast from a mixture of copper with tin—have been dug up in Ireland and various places. Cæsar says that the Britons made use of imported copper.

I have just noticed that copper has been found with other minerals in several places in this country. In Derbyshire only a little has been found. I have alluded to the celebrated copper mine at Ecton, in Staffordshire, from which immense quantities of rich ore were derived before 1770. It is, moreover, supposed that the main body of the mineral in that spot has been long since exhausted, and that the subsequent workings have been

* Copper is probably derived from Cyprus (the Greek word being the same, *Kupros*), on which island there were mines of the metal.

only upon branches of it. Cornwall, however, is the great source of copper, an amazing quantity of which is constantly in the home market. "The history of Cornish copper," says Mr. Warner, "is as a mushroom of last night compared with that of *tin*. Lying deep below the surface of the earth, it would be concealed from the inquiries of human industry, till such time as natural philosophy had made considerable progress, and the mechanical arts had reached their present state of perfection; for, notwithstanding tin in Cornwall seldom runs deeper than fifty fathoms below the surface, good copper is seldom found at a *less* depth than that. Accordingly we do not find than any regular researches were made for copper ores in Cornwall till the latter end of the fifteenth century, when a few adventurers worked, in an imperfect manner, some insignificant mines. Half a century afterwards, in the reign of Elizabeth, though the product of the mines would naturally be greater than before, yet little advantage seems to have been derived to the country at large from the working of its copper. Writers hint at the mystery made of its uses by the merchants. In the next reign, however, all mystery was dispersed; the mines were inspected, their value determined, and a system was introduced of working them to greater advantage."

This beneficial change was effected by the vigilance of Mr. Norden, Cornish surveyor to the Prince of Wales, who discovered to James I. certain frauds adopted to conceal the real value of copper from the mines.

Afterwards the secret of its value became divulged, and copper mining progressed. Yet so wretched was the knowledge of mineralogy before 1712, that the yellow copper ore, at present so valued, was considered of no importance, and thought to be only dust, and was in fact cast aside as "mundic." In 1712, the copper manufacture of England was brought to great perfection; and in the reign of George I. the Cornish mining system in general, and particularly as relating to copper, was further improved, particularly by John Costar, a good metallurgist, mechanic, assayer, and drainer. He gave a new character to the whole business; and we find the quantity sold from 1726 in-

clusive to the end of 1735, was 64,800 tons, at £7, 15*s.* per ton. Passing on to the period from 1766 to the end of 1777, we find that 264,273 tons of copper ore were sold at £6 : 14 : 6 per ton. Coming down to 1807, we find 73,405 tons of copper sold in the year for £630,267 in the whole.

THE PARYS COPPER MINE.

The Parys copper mine in Anglesea was almost a mountain of copper, a sort of British Burra-Burra; but the mine has been worked out. We must be indebted to a somewhat old traveller, Warner, for an abridged account of a visit to it:—"On the ensuing morning," says Richard Warner (writing in 1799), "we left Amlwch to visit the Parys mountain, and survey the mine. This vast natural accumulation of mineral, which measures a mile in length and half a mile over, rises to the south-east of the town, about two miles from it. Its appearance is waste, wild, and barren in the extreme; not a vestige of green is seen on its parched and scarified surface, all vegetation being prevented by the sulphureous fumes which arise from the roasting heaps and smelting-houses, and extend their destructive effects for miles around."

Our ancestors worked the mines of this country, and exchanged their produce for various articles of foreign commerce. The instruments they made use of in Anglesea are frequently found in and near the mountain, smooth, oval stones (their ends splintered and fractured), with which they broke the masses of ore, after having separated them from the parent rock by heating it intensely, and then pouring water or vinegar upon the ignited part. How long a time elapsed after the Roman period before this vast bed of mineral was again worked is uncertain. In the reign of Elizabeth, the mines of Parys mountain were granted to certain patentees in order to be worked. After this time they seemed to have slumbered in neglect and oblivion for a century and a half, when an accidental circumstance again brought them into notice. The account is given by Pennant:—"In the year 1762, one Alexander Frazier came into Anglesea in search of

mines. He visited Parys mountain, called on Sir Nicholas Bayley, and gave him so flattering an account of the prospect, as to induce him to make a trial and sink shafts. Ore was discovered, but water overflowed the workings. About two years after, Messrs. Roe, applying for a lease of another mine, were, much against their wills, compelled to take a lease of part of this mountain, and to carry on a level and a fair trial. This was made, ore was discovered, but the expenses overbalanced the profit. They continued working to great loss, and at length determined to give up the affair. They gave their agent orders for that purpose; but he, as a final attempt, divided his men into ten several companies, of three or four in a partnership, and let them sink shafts in various places, about 800 yards eastward of a place called the *Golden Venture*, upon a presumption that a spring which issued from near the place must come from a body of mineral. This conjecture was right; for in less than two days they met, at the depth of seven feet from the surface, the solid mineral, which proved to be the vast body which has since been worked to such advantage. The day of the discovery was March 2, 1768, ever since observed as a festival by the miners."

"Our first visit," says Warner, "was to the *Mona* mine, as it is called, of which language is utterly inadequate to convey a distinct idea. The wonders of this abyss are not concealed by a superficial crust of earth, but all is open to the day. The bowels of the mountain are literally torn out, and the mighty ruin is subjected to the eye. Standing on the edge of the excavation, the spectator beholds an awful range of huge caverns, profound hollows, stupendous arches, gloomy passages, and enormous masses of rock. Amid this striking scenery the miners are engaged in their curious but perilous occupations; some sticking to the sides of the rock, or seated on the narrow ledges of precipices, which gape beneath them to the depth of one or two hundred feet, tearing the ore from the mountain, and breaking it into smaller masses; others boring the rock in order to blast it; whilst a third party are literally hanging over the abyss below them, drawing up and lowering down the ore buckets,

supported only by a frame of wood work, which quivers like an aspen leaf with the operation carrying on upon it. Ever and anon we heard loud explosions rattling through 'the dark profound,' occasioned by the discharge of the gunpowder, and in separating the ore from the mountain. The reports varied, increased, and multiplied amongst the passages and caverns of the abyss, and, united with the scene of rocky ruin below us, excited the idea of the final consummation of all things."

What would Warner have thought in a deep coal pit?

"These excavations are, some of them, above 300 feet deep, the body of ore being found thus low, and in general increasing in value the deeper it descends. From this great depth, and probably far beyond it, the mineral rises within a few feet of the surface.

"Large masses of ore being separated from the mountain, they are afterwards broken into lumps, from one to two pounds in weight, and shipped to Liverpool or Swansea."

The traveller goes on to describe the preparation of the ores, and mentions that the dressed ore was carried to the *buddle*. The water of the slacking pits and buddles thus became strongly impregnated with mineral particles. Reservoirs were formed, into which the water thus saturated was conducted by proper channels. In these, plates of cast-iron were immersed vertically, and were apparently almost transmuted into copper.

This process of apparent transmutation was more complete in respect to the water pumped up from the bottom of the mine. By these means, a "prodigious emolument" arose to the proprietor. The water, dissolving all the native copper it found, became richly saturated. The acid of the copperas seized upon the iron plates, or combined with the iron, and the copper held in solution dropped to the bottom in a rust-coloured sediment. A man or boy scraped the copper from the plates of iron daily, until the whole of the iron was consumed. The precipitate was then raked out, and, being dried, became almost of equal value with native copper. Further, from the reduced iron was made a quantity of red or yellow ochre. Such was the wonderfully productive Parys copper mine.

LOCALITIES OF COPPER—FOREIGN MINES IN SWEDEN, GERMANY, AUSTRALIA, UNITED STATES.

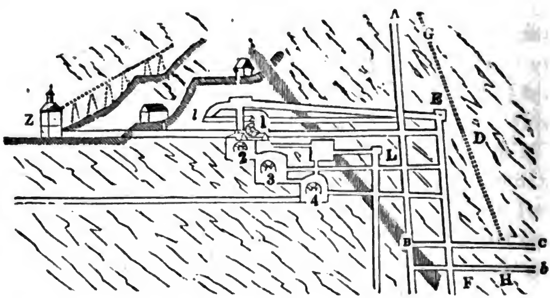
Copper is of such common occurrence, that it would be in vain to enumerate the localities where it is found. It is enough to say in brief, that it is produced in Africa and America, in Persia, China, and Japan. The Siberian mines are very productive, both in ore and native copper. Siberia, too, is famous for that very beautiful green ore of copper, called malachite. The magnificent works in malachite exhibited in the Crystal Palace, or Great Exhibition, in Hyde Park, will not be forgotten; nor will the massive and splendid malachite doors, and the splendid vases and other ornaments, of the same beautiful material. The visiters also to Windsor Castle will remember the splendid malachite vase presented to our sovereign by the Emperor of Russia.

Almost every country in Europe yields some copper. The mines in Sweden, Norway, and Germany are very rich. Sweden is scarcely less celebrated for its copper than its iron mines. The principal is that of Fahlun, in Dalecarlia, forty leagues north-west of Stockholm. It is excavated in an irregular and very peculiar mass of pyrites. It is asserted that this mine was explored before the Christian era. During its greatest prosperity it is said to have produced eleven millions of pounds avoirdupois, or about 5000 tons of copper per annum. It now furnishes about the seventh part of that quantity, yielding at the same time about 70,000 pounds of lead, with fifty ounces of silver, and three or four of gold. The ores smelted at Fahlun produce from two to two and a half of copper per cent.; but sulphur is also procured, and some chemical products. Round Fahlun, within the space of a league, seventy furnaces or factories of different kinds may be seen. The workings of the mine are penetrated by shafts and galleries, and have arrived at the depth of nearly 430 yards. They display space enough to admit the employment of horses, and forges for repairing the miners' tools.

In the copper mine of Garpenburgh, eighteen leagues from Fahlun, there occur fourteen masses of ore quite vertical and parallel to one another, and to the beds of mica-slate in which they stand. This mine has been worked for more than 600 years.

THE RAMMELSBERG MINE.—One of the most curious foreign mines is the celebrated mine of Rammelsberg, in the Harz. The mineral deposit is situated in the earth like an enormous inverted wedge, so that its thickness increases as it descends. At about 100 yards from its outcrop, it is divided into two portions or branches, which are separated from each other during the whole known depth by a mass of very hard clay-slate. The substances composing the workable mass are copper and iron pyrites, with galena, and other accompaniments. This ancient mine has been known from the year 968. It is worked by shafts and galleries, with the employment of fire to break down the ore. It produces annually about 275,000 lbs. avoirdupois of copper.

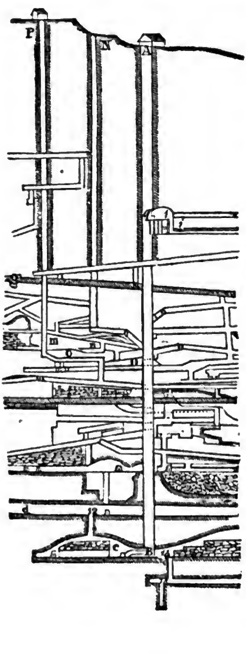
A mine so ancient cannot fail to present a great variety of shafts and excavations; but out of the fifteen pits only two are employed for the present workings. The following illustration gives some idea of the mine:—



The pits marked A B and E F, are those by which the whole extraction and drainage are executed.

The general system of excavation by fire in these mines, proceeds in a regular manner. There are formed in the level to be worked, large vaults in the heart of the ore by fire, and the ores

detached by the fire from their bed are picked and gathered, and then wheeled towards the shaft of extraction, and turned out to the day. By a fixed plan, piles of fagots are arranged in the mine, and it is usually on a Saturday that all the piles of fagots distributed during the week are kindled. Those in the upper floors are first burned, and kindled in the upper ranges at four o'clock in the morning, from pile to pile, and very soon the fire unfolds its wings in the metallic vaults, which are filled with vast volumes of smoke and flame. In course of time the ores pass into a shattered and divided condition, which allows them to be afterwards detatched by long forks of iron. The combustion goes on without any person entering the mine from Saturday evening to Monday morning, when the fireman and his assistants proceed to extinguish the remains of the bonfires. On Tuesday all hands are employed in detaching the ores, sorting them, and taking them out, and preparing new piles against the next Saturday.



The adjoining figure will show a longitudinal section of part of this mine.

A B is the shaft of extraction; N is the ventilation shaft; and P is another extraction shaft. The processes in brief are these:—The bed of ore is reached by the transverse galleries *m*, *n*, *o*, *q*, R, *s*, which branch off from the extraction shaft, and terminate at the wall of the main bed. Great vaults are scooped out at the level of the workings by means of fire. The roofs of these vaults are progressively propped with mounds of rubbish. The ores detached thus, or by blasting with gunpowder, are then collected, and lastly wheeled out and washed.

The Burra-Burra Mine.—The most extraordinary copper mine of modern times for produce, is that of Burra-Burra, in South Australia. It was started on the 5th September, 1845, with a capital of £12,320, subscribed by a few merchants and traders of Adelaide. The returns of ore have been as follows:—

	TONS.	CWT.	
September 30, 1846	6,359	10	Total produce in five years of 56,428 tons, 3 cwt. of copper ore.
1847	10,794	17	
1848	12,791	11	
1849	7,789	16	
1850	18,692	9	

This ore has varied in quality from ore containing thirty per cent. of copper, to much that produces seventy per cent. The money value of the above quantity is £738,108. The mine has been stopped by the gold discoveries.

Copper near Lake Superior, United States.—There are very rich deposits of copper about Lake Superior, which may one day occasion large establishments.

It has been known for some time that very rich deposits of copper existed in this locality, and mines have been worked there, though under many disadvantages. The Cliffe mine, the deepest and most extensively worked in the district, commenced in 1848. It has repaid its original capital four times over, and is very prosperous, the lode being regular and continuous, and improving in richness to the depth of 500 feet, which has been already attained. The North West, North American, and Copper Falls mines, in the same district, have also been fortunate, and, where capital has been expended, the results seem to have been very favourable.

An English company has recently started to work silver and copper mines at Keweenaw Point, three and a half miles southeast of Copper Harbour. They have purchased 1240 acres, and declared the ores to be "unprecedentedly rich in copper and silver." The geological situation is peculiar, as the upper lodes traverse two kinds of rock—greenstone and amygdaloidal trap,*

* Probably a volcanic rock.—Trap is so called from the Swedish *trappa*, a stair.

in the former of which they are poor, and in the latter rich. The veinstone is quartz and calcareous spar. Several courses of pure copper have been found. The most striking feature in the ore of this locality is its richness in copper. The company issued a report, that the yield of samples of dressed ores from both the veins they at present possess, is in one vein 84·9 per cent., and in the other 87·9 per cent. of pure copper, this being viewed as the highest; yet the general produce is said to be very rich. The average yield of Cornish copper ores varies from six to eight per cent., and hence the cost of transporting the copper ores from the Lake Superior districts to smelting-works and an available market, can readily be afforded out of the superior richness of the ores. Rich specimens of silver and copper have been found. The silver is not associated with the masses of copper in the form of alloy, but is intimately mixed in grains and strings.

One extraordinary lump of copper was found on the shores of the lake, estimated to weigh about eighty tons, measuring fifty feet in length, and six feet in depth, and averaging six inches in thickness.

DRESSING COPPER ORES.

Having spoken with so much detail on the dressing of tin ores, and having illustrated the several processes, I shall only briefly notice the operations connected with the dressing of copper ores. A number of operations must be performed, that the ores may be ready for smelting; but after all these operations, only from six to eight per cent. of pure metal can be obtained from the ores.

The first process is to throw aside the *deads* or rubbish with which the ores are invariably intermixed. This process is cleverly performed by girls of seven or eight years of age, for threepence or fourpence per day. The largest fragments of ore are then *cobbed*, or broken into smaller pieces by women. Then, after being again picked, they are given to the "maidens," as the Cornish people term girls from sixteen to seventeen years

of age. The maidens *buck* the ore with a *bucking-iron*, or flat hammer, by which they bruise the pieces to sizes not exceeding the top of the finger. The ores are now given to boys, who *jig* them, or shake them in a sieve under water, by which means the ore or heavy part keeps at the bottom, whilst the *spar*, or refuse, is scraped from the top. The part which passes through the sieve is also stirred about in water, the lighter parts being thrown on the surface; and the ores thus dressed, being put into large heaps of about 100 tons each, they are then made ready for market. The copper ores are shipped for Wales, and mostly for Swansea and its vicinity, in order to be smelted; for it is much cheaper to carry the ores to the coals, than the coals to the ores, and the Cornish copper miner is wholly ignorant of smelting processes. Copper ores can be smelted in small lumps, but tin ores must be previously reduced to the finest powder. Hence the difference of the processes; and hence, though both sets of processes are performed by dressers, the one class of dressers are quite incapable of performing the work of the other.—"Tinmen are not copperers," as the Cornish miners say.

In the visit to the mine on the moor, I described the general appearance of a large dressing-floor of a mine, with its machinery and its working people.

SALES AND PRODUCE OF COPPER ORES IN CORNWALL; TABLES.

We now confine ourselves to our own country, and the Cornish copper mines. The number of these mines in Cornwall is not easily ascertained, because many Cornish mines include the produce both of copper and tin. Mr. Watson stated in 1843, that there were about 112 copper mines in Cornwall, employing in and around them 60,000 persons.

I have already alluded to the singular difference between the sales of tin and copper ores. The tin ores are purchased by Cornishmen, but the copper ores are conveyed to Welshmen; Cornish tin is mostly smelted in Cornwall, Cornish copper in Wales. The stannary laws of Cornwall have led to the establish-

ment of tin smelting-works in that county; and the abundance of coal in South Wales has led to the establishment of copper smelting-works in that country. Thus the copper ore is carried to Swansea to be smelted, and coal is brought from Swansea or other Welsh ports to smelt tin and supply steam-engines in Cornwall. The sales of both ores take place in Cornwall in the following manner:—

When a quantity of copper ore has been properly dressed, each miner's parcel is weighed by a mining captain, and turned over to the general heap called the public parcel, which has previously parted with three average samples. An assay-master assays these samples; one being assayed for the company, another for the miner, and the third is retained in the office of the mine for reference. The ore having been really sold, the amount due to the working miners depends upon the quality as determined by assay, and the ratio of "tribute" agreed upon, and the amount is placed to the account of each party or partnerships of miners.

The ores are sold weekly, meetings being held for the sale of tin ores every Tuesday, and for copper ores every Thursday. These weekly sales are called *ticketings*, and present a curious feature of interest to strangers. The ores being made up by the tributers into heaps of about 100 tons each, samples or little bags from each heap are sent to the agents for the different copper companies. The agents take these to the Cornish assayers—a set of practical but not scientific men, who can, however, by long use, determine with accuracy the value of each sample of ore. I visited an assayer in Cornwall, and was surprised at his unacquaintance with chemistry and metallurgy, yet he was a good "practical man." As soon as the agents have been informed of the assay, they determine what price per ton they will offer, in the names of their respective companies, for each heap of ores at the weekly meeting or ticketing. At this ticketing meeting all the mine agents, as well as the agents for the several copper companies, attend; and it is a singular feature of their meeting, that the whole of the ores, amounting to several thousand tons, are or may be sold without the utterance of a

sentence. The agents for the copper companies, seated at a long table, hand up individually to the chairman a *ticket* or tender, stating what sum they offer for each heap. As soon as every man has delivered his ticket, they are all ordered to be printed together in a tabular form. The largest sum offered for each heap is distinguished by a line drawn under it in the table, and the agent who makes this offer is the purchaser.

The sales take place at Redruth, Truro, and Pool. At one of these sales 3323 tons of ore have been sold in an hour or two. This amount would produce 266 tons 15 cwt. of fine copper, and the amount of sale in money would be no less than £20,124, 5*s.* the standard of copper then being at £109, 14*s.* The value of copper ores depends so entirely on their character, that no general price can be given; some ores bring £20 per ton, and some only £2. In the sales of 1849, the average per ton was £5 : 4 : 3 as sold in the ore.

The following table gives the average price of copper *ores* for some years, divided into convenient periods:—

Years.	Price per Ton. £	s.	d.	Years.	Price per Ton. £	s.	d.
1700	2	10	0	1822	6	7	0
1730	7	5	10	1832	6	1	6
1750	7	6	6	1842	6	4	4
1779	5	16	0	1844	5	6	10
1797	7	17	8	1846	5	11	7
1805	10	1	10	1850	5	8	0
1817	8	15	4	1852	5	8	6

The low price in 1779, probably arose from the immense quantities of copper thrown into the market from the celebrated Parys mountain, in the island of Anglesea.

The following are the particulars of the produce of copper from the Cornish and Devon mines for the year 1852. The quantity of copper ore was 165,593 tons; of copper, 11,776 tons 17 cwt.; the value in money was £975,975, 14*s.*; the average produce of copper in the ore was $7\frac{1}{8}$ per cent. The standard of copper was on the average 121·10.

The reader may be interested in learning the produce of some

of the principal copper mines in Cornwall. The following is the produce of a few of the larger mines for the five years 1848-52, both inclusive:—

NAME OF MINE.	ORE.	COPPER.				MONEY AMOUNT.		
	tons.	tons.	cwt.	qrs.	lbs.	£	s.	d.
Devon Great Consols	88,963	8,192	14	1	22	545,648	13	0
Carn Brea	44,115	3,964	14	3	2	267,871	1	6
Consolidated Mines	35,446	2,709	19	0	6	183,733	17	6
United Mines	51,896	3,330	16	1	22	226,707	15	6
Fowey Consols	28,311	2,496	19	0	20	165,751	18	0
Par Consols	35,672	3,407	18	2	15	228,618	2	0

From a table of the sale of copper ores sold at the Cornwall ticketings, *for the quarter* ending December 30, 1853, it appears that the total sales amounted to 45,522 tons, and the amount of these in money was £312,371, 11*s.*

It may interest the reader to see the names of the purchasing companies, and the amount they purchased, which we give as follows from the Mining Journal:—

Companies by whom copper ores, for quarter ending 30th December, 1853, were purchased; with quantities and value:—

NAMES OF COMPANIES.	TONS.	VALUE.		
		£	s.	d.
Williams, Foster, and Co.	9,110	72,440	13	7
Freeman and Co.	4,360	25,318	4	3
Vivian and Sons	7,169	44,077	1	2
P. Grenfell and Sons	5,708	41,966	18	2
Sims, Willyams, and Co.	5,120	33,703	6	5
Mason and Elkington	4,862	31,862	3	5
Copper Miners' Company	3,572	21,471	8	4
English and Australian	2,815	18,327	18	4
Mines Royal	1,848	13,091	9	3
Crown Copper Company	560	5,642	9	1
F. Bankart	598	4,669	19	0
Total	45,722	312,371	11	0

The above firms are the principal Smelters.

To show the gradual increase of the British copper trade, I

append a tabular view of the sales of copper ore at Swansea, since the commencement of the trade at that port to the year 1850.

YEARS.	WELSH.	IRISH.	ENGLISH.	FOREIGN.
	tons.	tons.	tons.	tons.
1804	52			52
1806	41	62		103
1810	400	603		1,003
1815	1,079	700	77	1,856
1820	124	2,200	1,408	3,782
1825	1,191	5,350	2,061	8,602
1830	1,788	9,115	415	12,252
1835	3,770	22,306	268	32,919
1840	1,525	20,166	752	57,797
1845	1,914	19,647	622	68,826
1850	2,460	26,053	1,162	11,811

To show the produce of copper ores in Cornwall, I subjoin a table of annual produce, from the year 1845 to the year 1852.

YEARS.	ORES.	COPPER.	AMOUNT IN MONEY.	AVERAGE PRODUCE OF COPPER.
	tons.	tons. cwt.	£ s.	per cent.
1845	162,557	12,883 3	919,934 6	$7\frac{7}{8}$
1846	150,431	11,850 14	796,182 6	$7\frac{7}{8}$
1847	155,985	12,754 0	889,287 0	$8\frac{1}{8}$
1848	147,701	12,241 19	720,090 17	$8\frac{3}{8}$
1849	146,326	11,683 13	763,614 19	8
1850	155,025	12,253 10	840,410 16	$7\frac{7}{8}$ 1-16th.
1851	150,380	11,807 8	782,947 8	$7\frac{7}{8}$
1852	165,593	11,776 17	975,975 14	$7\frac{1}{8}$

To the above, I add finally another table of detail, for the year 1849.

QUARTERLY SALES OF COPPER ORES IN CORNWALL, FOR THE YEAR 1849.					
QUARTERS ENDING.	ORES IN TONS OF 21 CWT.	QUANTITY OF FINE COPPER.	AMOUNT OF SALES IN MONEY.	PER TON AVERAGE.	AVERAGE STANDARD OF COPPER.
	tons.	tons. cwt.	£ s. d.	£ s. d.	£ s. d.
March 31.	36,093	2,901 11	188,507 0 6	5 4 5	98 12 0
June 30.	36,631	2,906 14	187,167 15 6	5 2 2	98 16 2
Sept. 30.	37,103	2,992 17	194,495 11 6	5 4 10	97 14 1
Dec. 31.	35,508	2,810 2	193,444 11 6	5 5 7	104 10 11
Totals . . .	146,335	11,691 4	763,614 19 0	5 4 3	99 18 3

The above tables will afford to the inquirer information on the produce of copper ores; and suggest, by comparison, inferences that need not be detailed. It is only unfortunate that all such statistics are difficult to obtain.

The term "standard of copper," relates to the price of the metal. It denotes the estimated value of the fine copper per ton, considered from the various assays to be in the ores sold; less a fixed sum per ton, namely, £2, 15*s.*, which is deducted for the cost of smelting. Since the improvements in obtaining the pure metal from the ores on the large scale are greater than the assays would shew, copper is now usually sold under the standard, which fluctuates considerably.* These fluctuations are anxiously watched by miners and speculators. When I began this book the standard of copper was £125, 5*s.*, but it has since varied considerably. In 1804, it was as high as £136; in 1805, it was £169; the highest point attained for a series of years.

REDUCTION AND SMELTING OF COPPER ORES.

The treatment of the copper pyrites for the extraction of the metal, consists of a long series of processes, alternately of an oxidizing and a deoxidizing character. These have for their object to remove the sulphur, and prevent the reduction of the iron of the ore, whilst the copper may be separated in a metallic state. The whole processes are usually eight in number, and are performed in reverberatory furnaces at very high temperatures, and consequently at a great cost and consumption of fuel.

The fuel consumed in producing a ton of metallic copper is usually estimated at from eighteen to twenty tons. At eight and a half per cent. of metallic copper, the weight of ore necessary is twelve and a half tons. As to the coals, twenty tons of Swansea coal would cost at the least £6 sterling; and if the ton of fine copper were taken as worth £90 at the lowest range of prices (now it is worth much more), then the cost of fuel would make up about six and two-thirds per cent. of its value; and so in pro-

* On August 17, 1854, the average standard of copper is £139, 2s.; average produce of ores, 6¼; price per ton, £6; quantity of ore sold at Truro, 4199 tons; amount of money, £25,185, 11s.

portion to the value of copper. When the copper ores are brought from Cornwall to Wales, they are discharged from the vessels in which they are brought, wheeled into the yards contiguous to the works, and there deposited, one cargo above another; so that, when cut down perpendicularly to be carried to the furnace, a general mixture is formed, which is always desirable in a smelting-work.

All the copper is conveyed to Wales for reduction to the metallic state; and this on account of the supply of fuel. Thus the smaller quantity—the ore—is conveyed to the greater quantity—the coal; and the conveying vessels load back coal for the use of the mining steam-engines. The principal smelting-works are situated on the navigable rivers of Swansea and Neath.

During the five years, from 1848 to 1852 inclusive, the total of copper smelted at Swansea from English mines, was as follows:—

ORE.	COPPER.				MONEY VALUE.		
tons.	tons.	cwt.	qrs.	lbs.	£	s.	d.
765,025	59,943	9	3	6	4,083,039	14	6

The processes in copper work are simple, and consist in alternate calcinations and fusions. By the former the volatile matter is expelled, and the metals previously combined with the copper oxidized; the general fusibility of the mass being thereby increased. The furnaces in which these operations are performed, are reverberating, and of the usual construction for such furnaces.

The substance to be acted upon is placed on the body of the furnace or hearth, which is separated from the fireplace by a bridge of bricks of about two feet in thickness. The flame passes over this bridge, and, reverberating along the roof of the furnace, produces the required temperature, and escapes, with any volatile matter that may be disengaged from the ore, through a flue at the opposite extremity of the furnace, and this flue communicates with a perpendicular stack or chimney. The details of the process are to be found in technical works, such as Dr. Ure's Dictionary of Arts.

Every one who has lived, lodged, walked, or dined, near copper

works, knows the noisome effects of the said works. In the year 1821, the great Hafod copper works, in the neighbourhood of Swansea, which were erected at an expense of about £150,000, were indicted for a nuisance, in consequence, as alleged, of the destructive effects of the fumes. Sir Humphrey Davy had been applied to on the subject, and much has since been done to abate the nuisance; but all the chemists in the world cannot make a great copper work a pleasant or even innocent neighbour. Dr. Paris, in his life of Davy, remarks that, at that time, the amount of wages paid by the proprietors of the works in this district, exceeded £50,000 per annum; that 12,000 persons, at the least, derived their support from the smelting establishments; and that a sum of not less than £200,000 sterling was annually circulated in Glamorganshire and the adjoining county, in consequence of their existence; and further, that they paid to the collieries no less than from £100,000 to £200,000 per annum for coal. As to conveyance of ore, 150 vessels were employed in that business, and, supposing each upon an average to be manned by five seamen, they gave occupation to 750 mariners. Now, such results showed that the olfactory nuisance was greatly counterbalanced by commercial benefits. There are now, however, plans proposed, and partly in action, for a perfect and economical condensation of metallic fumes.

The operations for *rolling the copper* are carried on contiguously to the Hafod works, on a large scale. There the cakes of copper are manufactured into sheets and sheathings for export and home consumption. Government has, for several years, maintained an establishment at Portsmouth for the manufacture of copper into sheets and bolts. In 1831, at those works, 580 tons of copper were used, and in 1832, 644 tons.

USES AND MANUFACTURES OF COPPER.

The uses to which copper is applied in the arts are numerous and important, and visible all around us, from a copper tea-kettle and tea-urn, to a copper coal-scuttle and the copper coinage. Go where you will in the manufacturing districts, copper is useful and necessary, whether in copper plates for engraving, in

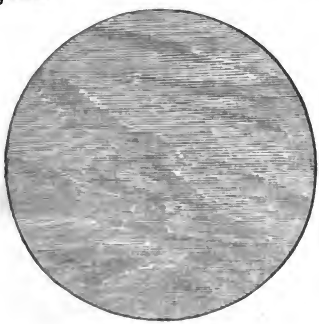
copper piping and tubing, in calico-printing rollers, in sheathing ships, in cocks for drawing liquids, in the alloys for brass and bronze, in alloys for guns, bells, and statues, or in a variety of minor uses and applications, which are all needful or ornamental.

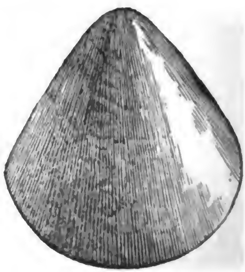
Copper—copper—copper—is with you and around you, from the copper coal-scuttle that fills your stove grate, that boils your copper tea-kettle, that fills your copper tea-urn, that makes ready your breakfast; while the bell that contains copper rings you to church, where you tread on sepulchral brasses, behold brass gas-holders in various shapes, and at the door of which, when you come out, you give your last copper coin to the brazen mendicant!

Copper is alloyed with tin in bronze, speculum metal, and bell metal; with zinc in brass, pinchbeck, tombac, and Dutch gold, and with nickel in German silver.

The malleability of copper is one chief characteristic of it in its uses, and is remarkably illustrated in the production of moulds for jellies, urns, vases, &c. Every school-boy has gazed with wistful eyes on the thin copper moulds visible in the confectioners' shops, meditating upon the sweet contents which those moulds often cover. Now, these moulds exhibit in their manufacture the malleability of copper very strikingly, as also do the vases and urns, which I may here illustrate by some drawings from the works of Messrs. Tyler, in Warwick Lane, London.

In the first instance, a circular piece of copper of the requisite thickness is taken and properly annealed, as in the first of these figures.





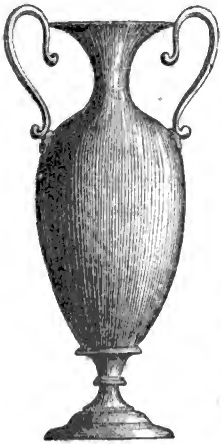
This is subjected to a process of hammering, which is uniformly carried over the whole surface, the disc of metal being dexterously turned inward by the workman during the operation. By this process, it eventually assumes the form shown in the next figure, resembling a copper boat. During the action of the hammering, the ultimate particles of the mass of metal must be driven closer together. But we do not know what takes place, and the secrets of these molecular changes have not yet been sufficiently examined. All we can now say is, that the metal becomes very brittle by long-continued hammering.

The vessel in question being brought into the shape of a bowl, it is submitted to the action of heat, and this process is called *annealing*. When cool, it is again hammered by the workman, and the third stage of the manufacture is represented by an approach to the conical figure, as shown in the first of the four annexed illustrations.

Up to this point the operation may appear simple, although in beating up a disc into a vessel eighteen inches high, much mechanical skill is required. Next, by careful manipulations, that portion which is to form the neck of the vase is produced; the process still being successive hammerings and subsequent annealings. The result is such a form as is shown in the second of the four figures above.

This operation must be very frequently repeated, as it is found that the change from ductility to brittleness takes place more rapidly in the advanced stages of the manufacture than it did

in the commencement of the process. In the third figure is shown the formation of the mouth of the vase, and in the fourth figure is shown the further development. Eventually the required form is produced, and the annealing operation being now carried with much care to such an extent as to ensure the required toughness to the vessel, the handles, &c., are adjusted, and the vase is completed, as shown in the subjoined figure.



Other things, as kettles, pitchers, and small vessels are soldered. The seams, after annealing in the manner just described, are found to stand the operation nearly as well as any other part of the article, care being taken neither to heat nor hammer those parts more than is essential. In boilers, gasometers, stove pipes, and other large articles, the pieces are attached by studs or rivets, driven, at short distances apart, through holes punched in the metal, and spread out on one side by repeated strokes with a hammer, while a small anvil is held against the head of the rivet. A copper tea-kettle presents a familiar but ingenious specimen of the coppersmith's art, both with reference to soldering and hammering; indeed, taken in all its parts, it exhibits the results of almost every operation of his workshop. Copper vessels, when not very large, and particularly if intended to hold liquids, or to dress food for human sustenance, are tinned inside. Various attempts have been made, and some patents obtained, to supersede the tinning of iron and copper vessels of a certain class, as used for culinary purposes, but with no beneficial results.

Sheet copper of the finest and purest quality is in extensive demand for engraving; and this demand continues, notwithstanding the large use of steel plates of late years for engraving. For this purpose, the metal, rolled to different thicknesses, so as to suit the sizes of plates, is sold by the makers to the London dealer, who cuts it according to convenience, planishes it, and

gets up the surface in that beautiful dead smooth style admired by engravers.

Sheet copper is also largely used for sheathing or covering externally the bottoms of ships, to defend them from the depredations of marine animals, as well as to preserve them from decay. The sheets are of various sizes, and rolled to different thicknesses; twenty-two ounces of metal to the square foot being reckoned very stout sheathing. The decay of that metal, however, from the peculiar action of the salt water upon it, is very rapid, and consequently the cost is very great.

LEAD AND MISCELLANEOUS METALS IN CORNWALL.

Although copper and tin are the main produce of the Cornish mines, we must not forget that other metals are mined in smaller quantities in this county. Much lead is found in Cornwall, and for the year 1852 I find that the Cornish produce of lead ore was 8998 tons 14 cwt., and the lead from the same ore equalled 6220 tons 6½ cwt. For the same year, in Devonshire, the produce of lead ore was 2977 tons 4 cwt., and of lead itself 1917 tons 8 cwt. The mine producing most lead in Cornwall was East Huel Rose, which yielded in 1852 as much as 2381 tons 3 cwt. of lead ore, giving 1607 tons of lead metal, and also from the lead 48,000 ounces of silver. In 1838, the whole lead produce of Cornwall was estimated at 1800 tons, being much less than the recent produce of a single mine.

The silver is extracted from the lead by Pattinson's process, a very beautiful application of science, to be explained in a future volume on lead, &c. Now the Cornish and Devon leads are very rich in silver, as the following statement will show:—

ESTIMATE OF SILVER FROM CORNISH AND DEVONSHIRE MINES IN 1852.

County.	Average proportion of Silver in each ton of lead.	Ounces of Silver in each County.	Value at five shillings per ounce.
	Ounces.		£.
Cornwall. . . .	35	250,008	62,502
Devon.	40	91,340	22,835

No statistical returns are accessible as to the present produce of miscellaneous metals from Cornwall. Some scattered notes of former years are all that can afford us any kind of information. Of iron ore it was estimated in 1837 that the produce was 30,000 tons. Including Devon, the produce was 40,000 tons per annum.

Of oxide of manganese, at about the same period, the export from Cornwall and Devon was about 5000 tons, and its total value at £8 per ton was £40,000. From 600 to 800 tons of the oxide of arsenic were then annually produced in Cornwall.*

MINING AS A PECUNIARY SPECULATION.

If Shakspeare had foreseen the delusions of modern speculation in mines, he could not more truly have characterized them than by saying :—

> "The earth hath bubbles as the water hath,
> And these are of them."

Metals are solid enough, and so are the schemes that profess to make men rich by mining them. An old writer in the time of Elizabeth, seems to have had some prophetic inkling of what would happen when he gave the following advice :—"A mineral man," says he, "should be an hazard adventurer, not much esteeming whether he hit or miss. If he happen to win, he must esteem it as nothing ; if he lose all, yet he must think he has got something. If he finds a rich vein, let him not esteem it ; for it is like a man stung with a nettle." Another old author says :—"When mines hit, it is the best got gear in the world, it is so profitable to all, and hurts none ; and when they hit not, though it be lost for a time, God is hereby honoured in searching hidden treasures out of the depths of the earth." "Very true," says the speculator with no dividends, "but I am not much consoled thereby."

There must be a bump of speculation in the craniums of multitudes of men, for losses after losses incurred by others fail to

* There is now a demand for Cornish antimony, and shot and cannon-balls are likely to be made from this metal, which does not become so shattered as iron.

teach them. In the year 1851, we had a mania for gold mining in California; in 1852, for gold mining in Australia; and, calculating the premiums at which shares were sold, it is estimated that no less than *three millions sterling* have been spent by that liberal but not over prudent gentleman, John Bull, Esq., during the gold fever. This time (December) last year, six Australian companies represented a market value of £1,285,000. Seven Californian companies represented £1,415,000. What a sad investigation it would be, if one could search into the actual results of these companies!

While there is such a wide and known field for mining speculation at home, surely to venture to the other side of the world without any certain knowledge, is the very sign and proof of speculative fever being at its height.

Let us, however, look only at home, and speak of mines which we *may* see, if we will go to them and into them; that is, if they are really in working order.

Now a man who buys a mining share, buys a share differing from a bank or railway share in several respects, and particularly in this, that a mining concern is in general a leasehold. The sett, or lease, frequently extends to twenty-one years, for which period the company work it, and derive their profits from its produce. The life of a mine, therefore, is not the life of a man, or a bank, or a railroad. Its life may be a duration of twenty-one years, or, it may be, of twelve years. That is to say, you must get your dividends and capital out of such a limited period. In particular cases there may be particular arrangements; but these you must search into, and take into your account. In all statements of conditions you will see given the length of the sett, and the amount of the royalty.

If you wish to know what "concerns" are offered for your purchase and participation, only glance any day at one or two columns of the advertisements in "*The Times*" or "*Mining Journal*," and you may find quite enough *openings* in which to *sink* your money. Before you get in, only remember the cry of the starling in the cage—"I can't get *out!*"

If you want "advice" as to the best mining securities, there

are some dozen gentlemen who inform you that they make it their special business to consult your pecuniary interests, and that at their offices you can obtain shares in some six-and-sixty most promising mines.

You are probably told that, as a mining shareholder in Cornish mines, you have the benefit of the cost-book system. Now the precise conditions of this system are not easy to ascertain. So indefinite have the legalities and liabilities of this system been found, that judges have sneered and remarked that no person could tell what the cost-book system really was. There are, however, some leading features clearly recognized in it, and some of these may be best understood by a contrast with the railway and joint-stock system.

Suppose two shareholders, one in a railway and the other in a mine, on the cost-book principle. The railway shareholder holds a share of a fixed amount, say £100, and by the Company's charter he is answerable for that full amount, whatever may have been paid up below it, while he holds the share. He can only get rid of his liability by disposing of the share by a stamped agreement. When, however, he has paid up the full amount of the share, as £100, his liability ceases according to the usual provisions of Railway Acts, although this view, hitherto held by all, has become rather unsettled by a recent legal decision; for a legal authority declared, that no provision in the deed could discharge the joint-stock shareholder from his liability for the debts of the company. I take, however, the general view, as to liability determining with the payment of the full share.

On the other hand, the mining shareholder holds a share the exact pecuniary amount of which cannot be stated. He may be called upon to pay £10 or £100, according to the demands of the mine, and therefore his liability is unlimited so long as he holds the share. But he has power at any time to surrender his share to the company, and to demand that they shall remove his name from the book, and release him from all liability, excepting his proportion of expenses from the time of last to next meeting, say two months. Here is a great advantage. While railway

shareholders have been ruined, by having shares which no one would buy, or even take as a gift, because of their liabilities, cost-book shareholders could scarcely be placed in a like position, for the mining company would probably declare the shares forfeited. Past liabilities may, however, be very serious.

Further, the other arrangements of the cost-book system present such sweeping calamities. Frequent meetings (monthly or bi-monthly) of the adventurers, the power to examine and pass accounts at such meetings, to make calls and declare dividends, to transfer and relinquish shares, &c., all tend to continue the concern in good order, and to manifest the real state of things to every shareholder, and the entire accounts of the mine are settled four or six times a year. If the adventurers find that the mine never becomes productive, they will probably soon abandon it altogether.

There are, however, many defects even in this system, chiefly arising from want of provision, and want of ready jurisdiction. These it is the purpose of a bill, about to be introduced by Mr. Collier, the member for Plymouth, to rectify. That bill is not yet printed, but its provisions, as viewed in a brief outline, seem excellent and adequate. The cost-book system is formed on statutes especially applicable to Cornwall, and Mr. Collier's bill would extend their benefit. A recent legal decision seems to allow of the application of the system to other localities. A prize essay has been written on the system.*

On this plan the numerous Cornish mines are conducted; but it must be remembered that all mines not so conducted are established under the provision of the joint-stock act, and shareholders in them become liable to its legalities. It is a serious thing to be a shareholder in a bad mining company under this

* In the smelting business the liability is not limited; if it were, the price of copper might possibly be reduced nearly twenty-five per cent. At present, smelting is a complete monopoly. If a parcel of copper is offered for sale, six or seven smelters perhaps unite, and will only give their own price for it, which the miner complains that he is compelled to accept. It is thought that if there were limited liability in this business, smelting companies would be formed in Cornwall, which would be alike beneficial to the miners, the manufacturers, and the public.

act. There is indeed only one condition more serious, and that is to be in the fangs of a shameless and sharp legal practitioner. That I fully believe to be the lowest depth to which poor suffering humanity can sink. One instance of legal acumen may lighten the gloom of our present thoughts.

A client, a friend of mine, whom I designate Hobson, invited his solicitor, Jobson, with his family, to a friendly visit at his country house. Jobson and family duly arrived at Hobson's little paradise. One day, after dinner, and over their wine, Hobson remarked, "I suppose, Jobson, you are getting on with that affair of mine about Timpson?"

"O, yes!" replied Jobson, "that will soon be all right, my dear fellow."

"Very well," rejoined Hobson, "pass the port, will you? and help yourself."

Jobson drinks several bottles of wine in all, and on the fourth departs full of good things to Gray's Inn.

A few months after, Hobson receives Jobson's bill, in which he finds the following items—

> "To attending you at your country house, staying four days receiving your instructions and advising with you in *re* Timpson, in several interviews, carriage hire, and incidental costs. . . . } £9 19s. 8d."

The above, though not a mining concern, was evidently conducted upon the *cost-book* system. Finally, Hobson had to pay the expense of entertaining Jobson, and also Jobson's charges for being entertained by Hobson. Jobson still legalizes in Gray's Inn. Reader, invite him to your country house!

But to return to mining: *The Times* newspaper has frequently contained this advertisement amongst its hundreds:—

> GOOD INVESTMENT.—Mr A B C, Mining Sharebroker, P., Cornwall, is at all times in a position to put Capitalists in good CORNISH MINES. Good Mines pay from fifteen to twenty per cent.

Now, there can be no doubt that the gentleman whom I allude to as A B C, is able to put capitalists *in* good Cornish

mines, and no doubt fifteen or twenty per cent is a capital thing, and there are not a few who would prefer it to three per cent. in the Funds, with a loss on selling out. But will A B C get you *out* of a Cornish mine when you have once found the bottom, and little or no copper there, or else a river or two of water? Never was the old Virgilian proverb truer in relation to any thing or place than a mine:—

> ———"Facilis descensus Averni,
> Sed revocare gradum, superasque evadere ad auras
> Hic labor, hoc opus est."

Yes, this is the labour, and most probably A B C of P., in Cornwall, would be found unwilling or unequal to the task.

I may observe generally, that in all countries the fascinating occupation of mining is a perfect lottery; for not only is it composed of blanks and prizes, but the whole number of the latter would not pay for the price of purchasing all the shares. In Cornwall, as elsewhere, it is known to the well-informed, that mines *in the aggregate* are a *losing* concern; and, for example, the quantity of copper annually extracted in Cornwall is not worth the money annually spent there on copper mining. It necessarily follows, then, that a number of people lose money by mining in Cornwall, and a few gain very large or moderate profits, as the mines may turn out. Mining, then, being a lottery, with a few prizes and many blanks, who are the people likely to gain the prizes? Is it at all probable that any A B C can put any body and every body into exclusively good mines? What A B C can put a prize into *your* hands, and a prize into every applicant's hands? What A B C on earth can do this? Let the uninformed speculator be assured that those only are certain to draw prizes who have drawn in moneyed speculators; and that those only are *likely* to draw prizes who have studied the subject, and have acquainted themselves with every important geological, mineralogical, and commercial fact concerning the mines in which they invest or speculate.

The best thing I can do for all persons who wish to *sink* their money in mines, is not to "put them in mines," but to put mines before them, in brief, as to their pecuniary results, so that they may form a judgment from the whole. After they

have read these few pages, I think they will acknowledge that mining proprietors are significantly enough styled "adventurers."

I propose to select some results from mining history both past and recent.

RISK, RETURNS, AND CHANGES.

Tin and copper mining, like the mining of precious metals, is very precarious. It may be said of this, as of the joys of life in general, that there is no certainty beyond the present moment. Veins which are very promising when first opened, sometimes fall off below, and occasion immense loss to the adventurers; or they may be wrought continuously with little or no profit.

On the other hand, mines and veins which at the outset promise little or nothing, come in time to yield large profits. Thus enormous fortunes are realized, and enormous losses suffered, without any possibility of foresight and prudence.

For example, Crinnis copper mine returned in one year a clear profit to the adventurers of £84,000; and Huel Alfred, in Hayle, yielded nearly £130,000, after defraying every needful outlay. Huel Vor divided £10,000 in three months. About 1760, Polgooth returned a profit of £20,000 a year for several years; and Polberrow, in St. Agnes, cleared £40,000 in one year. On the other hand, the loss at North Downs alone has been estimated at £90,000. It may be presumed that the aggregate of gains upon the whole is very moderate, if any, when the aggregate of losses is deducted.

Very recently there has been an almost unprecedented rise in the price of copper. This has been chiefly owing to the great falling off in the returns from foreign mines, more particularly from the great Australian mine called Burra Burra. The works of this wonderfully rich mine have been suspended for lack of labourers, those formerly working at them having quitted for the diggings of gold. The effect of this antipodal movement has been very favourable upon our home copper mines. The scales may be said to be suspended over Australia and Cornwall, and the fall in one produces a corresponding rise in the other. Thus many of our home mines have increased their profits and divi-

dends, and some have paid dividends which would otherwise have barely met their costs of working. In old and extensive mines many "pitches" will not pay for working during a low price of copper, and therefore the ores are left untouched in them. But when the price rises they can be worked to a profit, and brought to market to swell the returns. At such times even the refuse (Halvans) will pay, as at the present time.

Whether the price of copper be high or low, the cost and the expense of raising—say, 1000 tons monthly—will be just about the same; and if a mine, yielding that quantity, just meets its working expenses at a low and unremunerating standard, then a rise of £1 per ton gives at once a profit of £1000 per month. Thus, the influence of the standard value of the metal upon the property of the mine will be seen.

The present standard of copper* is about £125, 5s., at a produce of six three-fourths. It is expected to be as high as £150, for there are large orders for copper in the new French coinage. Lead has lately advanced several pounds per ton. In the copper sale of the third quarter of 1852, the foreign mines were short of the usual quantity to the extent of 1767 tons; the Irish mines, 670 tons; the Welsh mines, 25 tons—making altogether 2741 tons less than in the previous quarter; and this in the face of a great demand. On the other hand, the sales of Cornish and Devon ores were expected to exceed the last by about 3000 tons.

In order to present some general data for forming a judgment, I subjoin the total dividends paid on mines in the year 1852.

	£	s.	d.
British mines	261,267	10	0
Foreign	112,150	0	0
Irish	16,809	0	0
Welsh	16,380	0	0
Scotch	393	0	0
Australian	12,320	0	0
Total dividends in 1852	£413,081	0	0

* The standard is the smelter's term to denote the price of a ton of metal in the ore; from which standard he deducts £2, 15s. per ton, as equivalent to the expense of reducing the ore, as before explained.—P. 233.

For the purpose of comparison, I add the dividends paid in the British mines since 1845, as given in Watson's *Progress of Mining* in 1852, a useful pamphlet to mining speculators.

						£
Year ending	1845	on	18	mines	. . . . . .	215,450
Do.	1846	"	28	"	. . . . . .	151,838
Do.	1847	"	30	"	. . . . . .	155,381
Do.	1848	"	22	"	. . . . . .	129,024
Do.	1849	"	38	"	. . . . . .	185,741
Do.	1850	"	42	"	. . . . . .	213,570
Do.	1851	"	45	"	. . . . . .	216,486
Do.	1852	"	50	"	. . . . . .	261,267

From the above list it will be seen that the dividends paid last year on our home mines, have exceeded any former years, since 1845, by £44,781. But there are fifty mines in the list, whilst in 1845 eighteen mines only paid £215,450. This, however, may be accounted for by the fact, that in that year East Wheal Rose, then the greatest lead mine in the kingdom, paid £52,864, and the Devon Great Consols, £55,296—these two alone paying half of the whole amount of the eighteen mines. This year, East Wheal Rose, owing to the erection of more powerful machinery and other causes, has paid only £2240; and Devon Great Consols, although paying more this year by £5120 than it did in 1851, yet falls short by £9216 of the amount paid in 1845. Taking note of those things, the year 1852 shows a greater degree of prosperity among mines in general than in any former year.

Great fluctuations have taken place in mines during 1852-3, and the prices of shares have varied accordingly. Thus, the shares of the United Mines have risen from a minimum of £70 to a maximum of £950. Botallack has risen from £200 to £400. Basset, from £400 to £525. Buller, from £500 to £800. West Caradon, from £115 to £200. These are the most striking rises in mines.

In endeavouring to afford the reader some insight into the mining character of the year now closed, as I am penning these lines I am assisted by the able annual review by Mr. J. Y. Watson, who says, "I do not remember in any one year such great and frequent fluctuations in the value of mining property

as we have had in the year 1853. In the early part of it we had a period of great success amongst the productive mines, a state of excitement in the market for all descriptions of shares, and a run of high prices for dividend stocks; and the latter, if not the former, has continued to the end. Almost any thing, too, in the shape of a new mine would sell at a premium; and it may be supposed that the market was well supplied with speculations, all of them 'of the greatest promise' so long as the furor lasted, but few of these survived the effects of the panic, brought on by over speculation in the first instance, and made worse at last by wars and rumours of war in the East.

"In 1852, a great impetus had been given to mining by the high price of copper, the 'standard' being £132 at a produce of 7¼. On January 13th, it rose to £152, 5*s.*, with a produce of 6¾ per cent. On the 27th of the same month it reached £164, 14*s.*, with a produce of 5¾, this being the highest standard for many years. (In 1805, the standard was £169, 16*s.*, at a produce of 7⅞.) The price kept up pretty well for a few months, and the mines made large profits. Even the refuse ore, which had for years been lying upon the mines as valueless, was sold at a profit, and many new bargains, too, were set in mines which would not previously pay for working. Larger dividends were declared than had ever been paid before. About March, copper began to fall. In April, the standard had receded to £130, 10*s.*, produce 6⅝; May 12, £118, 17*s.*, produce 6½; and on the 19th, £113, 7*s.*, produce 7¼, this being the lowest point. After a time it slightly recovered, and thus it remained for some months; but in October and November it advanced, and it has now reached £148, 14*s.*, produce 6⅜ (December 22, 1853). The standard of copper bears the most important relation to the prosperity of our largest mines. A low standard, with high prices for materials and labour, would be ruinous to many.

"When the standard was so high the smelted article did not bear a proportionate price, possibly from a monopolizing tendency on the part of the smelters.

"The price of lead and tin fluctuates with the price of copper, but at present there is a remunerating price for all metals."

The total amount of dividends paid by British mines in the past year, from January 1st, to December 31st, 1854, have been unusually large, being no less than £329,014 : 18 : 6; and the totals for all will be seen in the following table:—

TOTALS OF DIVIDENDS IN 1853.

	£.	s.	d.
British Mines...	329,014	18	6
Foreign	173,134	0	0
Irish	22,676	13	4
Scotch	1,214	0	0
Welsh	29,445	0	0
Grand Total	£555,484	11	10

Out of the above, the dividends paid on sixty mines amounted to £329,014 : 18 : 6; and exceed the sum paid in any other year since 1845, by £67,747. Two mines alone, Devon Consols and Buller, have paid this year £110,464, and Basset has paid £30,720. Buller is termed "a young mine," and therefore likely to last many years. Devon Great Consols is "a great fact." Yet with all these dividends the year has been singularly barren in discoveries in the shape of rich deposits of either lead, tin, or copper, until a week or two since, when a discovery, said to be of great value, was made at Sortridge Consols, near Tavistock, and the mine rose in value to the premium amount of £24,000 in a few days. As to the "hot-lode" at the United Mines, above referred to, the discovery of which sent up shares from £40 to £450 each—both the heat of the lode and the ardour of the shareholders have considerably declined, and so have the shares.

From the above statements it will be inferred that the fluctuations in shares have been very great. Among the small mines and new projects, the fall has in many cases been from pounds to pence. At one mine, Wheal Unity, there has been an instance of the sudden changes which sometimes take place in mining concerns. Several of the shareholders resolved to throw up their shares on account of the poor returns of the mine, leaving little more than half the original number to proceed with the undertaking. Not many weeks ago, after passing a second cross-course, the lode eastward totally changed,

and in one part became productive of copper to the worth of £30 per fathom.

In the St. Just and Penzance district, owing to the high price of tin several mines have paid good dividends. Boscaw shares rose from £20 to £120 in a few weeks; but the "young mines" have, with few exceptions, disappointed the adventurers. Boscundle tin mine, near St. Austell, lately sold £6000 worth of tin in one parcel. It is a part of the old Charleston United sett, for many years one of the richest in Cornwall. In the neighbourhood of Hayle the Alfred Consols (favourite mines with speculators, &c.) lodes proved extremely rich, the ores being of a very good quality, and the ground appearing to improve in depth. It has paid this year £20,736 profit.

I now proceed to give very brief histories of some great and important mines with relation to their profit and losses, so that from these the reader may form a judgment of the remarkable character of such adventures. My limits will only allow notices of the more prominent concerns. First, I shall present a very extraordinary instance, and one which is perhaps unparalleled in this county:—

THE DEVON GREAT CONSOLS MINES.

In 1844, six lessees took from the Duke of Bedford the sett or lease for twenty-one years, at a royalty of $\frac{1}{15}$th dues, to be increased to $\frac{1}{12}$th so soon as a profit of £20,000 had been realized. The property was parted into 1024 shares, and £1 paid on each share. In the same year, by November, a rich copper lode was cut, and the profits paid working expenses without call. The lodes soon began to turn out so rich, that in the six years between the dates of 1844 and of 1850, the company extracted and sold nearly £90,000 tons of copper, for which they received £600,000. After paying all expenses, the Duke of Bedford received out of the above sum £44,000 for royalty or dues, while the shareholders received about £207,000, or more than £200 per share on £1 paid. No more was "called," for the £1 per share had been sufficient, and thus six years' dividends on

£1024 paid up capital, amounted to more than £200,000. Now an average annual dividend of £35 on each share is equivalent to 3500 per cent per annum.

Such a rate of profit speedily and greatly affected the market value of the shares.

They have risen from one high price to another, until, in the Share List of December 31, 1853, they stand quoted at £430, and they have previously been higher still. Of course, this must be looked upon as one of the greatest prizes in mining, and not so much as an example as an exception.

The Devon Great Consols are on one side of the river Tamar, and the South Devon Great Consols on the other. This latter is a distinct project, now promising well. Near to these is another mine of the present value of £36,000, and at the top of the hill is one of the present value of £84,000.

Let us now glance at other mines.

THE UNITED MINES.

These mines are situated in Gwennap, and consist of the several mines of Poldovey, Cupboard, and Ale and Cakes, which names show the quaint humour of those who baptize the infant mines in Cornwall. These are united in one concern, and in the first working divided a profit of £300,000. From some cause they gradually fell into decay, and caused an eventual loss of £50,000. After a time they were resumed with an outlay and loss of £30,000. Then they became the property of the Consolidated Mines Company; but when these latter changed hands in 1840, the United were again worked by a separate company, and in twelve months ending in June 1842, they made a clear profit of £10,699, 10s., the cost for working during that time having been £53,450 : 8 : 3, and the value of produce £64,149 : 9 : 1. From June 1841 to June 1842, the produce was 10,195 tons of copper ore, yielding £64,377; but this business has not done much more than pay the working expenses. The proprietors were then 100 in number, and the miners under the management of Mr. John Taylor.

About 1500 persons were employed. The deepest level was 200 fathoms, or 1204 feet, and the steam-engines worked to the extent of their power.

The mines had recently become so poor, and the expenses so encroaching upon the profits, that the managers, the Messrs. Taylor, were about to stop them; but eventually they sold them to the Messrs. Williams, of Scorrier, for £16,000, or £80 per share. These spirited purchasers proceeded vigorously and judiciously to work, leaving to the shareholders of the old company the option of going into the new. The purchasers have been lately rewarded by one of the richest discoveries made in Cornwall; and we now find that their shares have advanced from £80 to £950 each, being at the rate of £190,000 for what had shortly before been sold for £16,000!

The profits of the mine have since become about £4000 per month. Thus it has happened that old mines, upon the point of being abandoned by one of the most experienced and scientific managers in the kingdom, have been taken up by others, and made marvellously profitable. No instance can prove more forcibly the uncertain character of mining operations, and the almost impossibility of forming a fair estimate of future probabilities. Had the former managers been ignorant and inefficient, we might have attributed the failure to these causes, but the very reverse is the case—for skill, experience, and shrewdness, characterise the Messrs. Taylor.

The new discovery has been called the Hot Lode, and it is said that a gentleman in London, hearing that the water from one of the levels was nearly boiling hot, bought twenty shares, at about £70 per share. The result proves that he has not burnt his fingers, or scalded himself by getting into hot water.

GREAT WHEAL VOR TIN MINE,

Situated in the parish of Breage, three miles from Helston, has been the richest tin mine in Cornwall. More than £200,000 profit have been divided among the shareholders. In 1843 there were fifteen engines at work on this extensive sett, which had the ap-

pearance of a town, and the machinery was valued at £100,000. Here was put up the first steam-engine ever erected in Cornwall, between the year 1710 and 1714.

The lode from which the chief part of the ore was raised was still productive in 1843, when the mine employed 1200 persons; and the monthly cost of working had been, some few years before 1843, about £12,000 per month. The mine, however, became less profitable, and finally stopped. It is now to be resuscitated with a capital of £200,000. The present company consider £100,000 sufficient to bring the mine into a profitable state.

There was formerly a blacksmith's forge at the bottom of this mine, in full operation, at 1470 feet below the surface of the earth! All the miners' tools were steeled, sharpened, and repaired there, and bucket rods were cut and welded. The smithy was clear and free from dust, smoke, and sulphur, and did not in the least annoy the miners.

There were also smelting works on the mine, where they made their own tin. Thus a great and profitable tin mine seemed to wear out by degrees. It may, however, be successfully re-worked.

TRESAVEAN COPPER MINE.

This mine has proved a remarkable one in its changes and profits. It is well worth a visit on all accounts, and is within a walk of Redruth. Once or twice this mine has been abandoned as a failure. At length it was taken up by parties who persevered in exploring it, and have succeeded in discovering its wealth by an outlay of little more than £1000. Its continued richness affords an instance of extraordinarily fortunate adventure; for it has left a profit of more than £800,000. From 1838 to 1843, the profits averaged £30,693 per annum; the working cost being between £3000 and £4000 per month. During the eight years, from June 1834 to June 1842, there had been raised and sold from this mine 99,211 tons of ore, yielding £610,893 : 19 : 6. In one year, 1833, this mine divided

£630 per share, or in all £60,480. The mine is held in ninety-six shares, each share having about £20 paid up. The total dividends paid to the present company, up to this year, have been about £449,352, or £4,680, 15*s.* per share, besides having paid about the same amount in a former working. Thus, in a very short time hence, it will probably have paid altogether one million of profits, and that one million on a paid up capital of less than £2,000! Let no one, however, imagine another Tresavean is to be discovered. Such a prize is unique.

The following abstract of proceeds and costs on the working of Tresavean is an interesting statement, and such an one is rarely to be obtained.

Year.	Value of Ores.			Dues to Lord.			Cost, Labour, Materials.			Profits divided.
	£	s.	d.	£	s.	d.	£	s.	d.	£
1829	25,813	18	8	1,290	15	8	14,518	16	0	10,336
1830	41,162	8	6	2,063	2	7	22,135	7	4	16,800
1831	57,732	6	11	2,891	5	9	26,009	14	1	28,520
1832	75,380	12	11	3,769	9	11	32,124	10	3	38,880
1833	104,396	9	11	5,220	14	2	31,375	18	1	60,480
1834	90,132	13	6	4,563	14	8	39,433	8	8	47,040
1835	74,354	0	8	3,771	10	0	39,005	5	1	29,760
1836	93,728	8	9	4,747	10	1	43,661	17	0	48,000
1837	79,794	18	3	4,057	2	8	39,041	13	0	32,640
1838 To Oct.	60,686	16	6	3,083	9	1	29,656	7	3	31,680
Totals.	720,338	9	10	36,331	8	1	326,203	7	8	348,456

Several steam-engines are at work on this mine, which is very favourably situated on a slope of a hill, and is therefore very dry, and requires comparatively little machinery to draw water from it. A new engine shaft, completed about ten years ago, is twelve feet by six in diameter, and 276 fathom deep from the surface, or 1656 feet. The cost of sinking this shaft was £20,000. It took two years and two months in sinking, by twelve sets of men rising and twelve sets sinking. Thus, in all, 120 men were employed upon it at the same time.

On this shaft a steam-engine has been erected with a cylinder of eighty-six inches in diameter, and which works nine lifts of pumps, and lifts thirty-six tons six cwt. per stroke. The weight

of rock and setts off in the shaft amounts to fifty-nine tons, thirteen cwt., two qrs. The shaft main beam, with gudgeons, bearers, and connection, weighs fifty tons. The eight plungers weigh seven and a half tons. Four balance bobs weigh sixty tons, and four balance boxes eighty tons. Seventy-five fathoms of flat rods underground, weigh eleven and a half tons. The total weight of the engine when in motion, is no less than three hundred and fifty-three tons sixteen hundred weight! The cost of this engine, delivered in the mine, was £4185.

The machinery has been valued at £60,000; and the number of persons employed varies from a maximum of thirteen hundred.

In the descent and ascent of mines I have described the man machine at this mine, which, when the only one in the county, was an object of great curiosity. In this mine the lodes are in granite, and become profitless when they quit it and pass into slate.

DOLCOATH COPPER MINE.

This mine is in Camborne, and one of the oldest in Cornwall, having been worked with little interruption for nearly a century. The profits realized have exceeded £300,000 (one account gives £600,000); and the returns from 1814 to 1848 yielded £1,361,681 : 18 : 6. During the past few years, by sinking shafts and driving levels, tin and copper ore has been laid open to the value of £20,000, and has been left standing in the "backs." With the present price of metals, it is thought the mine can be fairly worked to give a profit of from £100 to £150 per month.

This mine was 300 fathoms (1800 feet) deep to the oldest workings. Pryce, more than sixty years ago, mentions Dolcoath as one of the most extensive and important mines in Cornwall, though its depth was then barely 100 fathoms.

In November 1814, a large cavern was discovered here at the depth of 170 fathoms from the surface. It was very irregular in form, and its dimensions were from eighteen to twenty

fathoms long, three fathoms high, and from four to nine feet wide. In the "valley," the workings were carried on to such an extent that no timber could reach from side to side in the levels, and still the lode was found to extend to a greater width. The miners worked in a swing stage, which they dropped against such parts of the side as they intended to take away. Then, letting themselves down by a swing chain ladder, they blasted, and got down immense quantities of rock. May old Dolcoath soon appear again in the dividend list; and there are signs of such a reappearance!

OLD CRINNIS COPPER MINE

Is situated in St. Blazey, near St. Austell, and was several times abandoned before it became profitable. In the year 1808, it was declared by Captain James Michel, one of the best Cornish miners of that day, to be "not worth a pipe of tobacco!" In 1809, Mr. Joshua Rowe of Torpoint, and co-adventurers, notwithstanding the general contempt for the mine, commenced working it again.

As it still remained poor, the adventurers dropped off one by one, leaving the entire cost of working upon Mr. Rowe. After laying out a few hundreds in a fresh part of the set, he discovered a rich mass of ore at about ten fathoms from the surface. Upon this becoming known, all the old adventurers again claimed their shares, although in the poverty of the mine they had refused to pay costs, and had saddled Mr. Rowe with all. Mr. Rowe went to law and resisted the claims of those gentlemen, and after some years obtained a verdict in his favour. In the short space of four years and a half, this mine made a clear profit of £168,000, besides paying for £20,000 law expenses.

After 1815, the mine became gradually poor, and was at last abandoned. Alderman Sir Matthew Wood, Bart., was one of the fortunate adventurers with Mr. Rowe. Mr. B. Wood, M.P for Southwark, had the management of the mine for many yea Such is another singular instance of mining changes.

The examples given above, together with those of the Co

solidated Mines, and Fowey Consols, annexed to the analysis of their establishments, present the most striking in Cornwall. Alternations of hope and fear, wealth and poverty, abandonment and resumption, are here displayed more signally than in any other commercial undertakings. And perhaps the force of these examples has continued to influence speculative minds from time to time, and to keep alive trembling hope where all seemed doubtful and unpromising.

Now that mining speculation has greatly revived, I feel it desirable to add a few words in relation to the general subject, to which I shall append some hints to speculators, and a brief history of one of that class of men.

The keen Cornish miners have a kind of proverb amongst them, which they keep pretty closely to their own companies, and which is to this effect:—That the county is divided into two classes, Cornish men and "Lun'oners," and that it is the privilege of the former to live—not by the mines, but by the latter; in other words, by the speculations of strangers. There is much truth in this.

It is well known to the experienced, that in Cornwall, as every where else, mines, in the aggregate, form a losing concern. I repeat that the quantity of copper annually extracted from Cornwall, is not worth the money annually spent in Cornwall in copper-mining. Therefore, while a few people gain very large profits, many people lose money by mining. Mining is a lottery, in which there are a few good prizes, but the great majority must draw blanks—or rather heavy losses. Now, as the majority must draw the blanks, the great probabilities are that any new adventurer will be of their number. To avoid blanks a man must have experience, knowledge, skill, and be a local resident or frequent visiter to the mine. Hence I infer that foreign mining speculation is pure haphazard to the man who purchases shares at home, knowing nothing of the mines abroad. The attempts in times past to work mines in America by Cornish miners have proved abortive. Taking shares in *established* foreign mines is another thing.

All the money made in Cornish mines is not made by mining.

Some of the proprietors, or "adventurers," manage to be appointed to supply the mines with provisions and stores, as "pursers." If a man gains a good profit on coals, candles, iron, rope, safety fuze and gunpowder, then he is clearly better off than the shareholders who have to pay him that profit. Look at the lists of stores in my analysis of two great mines, and you can guess the gains by profits on each article.

If adventurers wish to get rid of a concern, it is not impossible to give it a temporary appearance of doing well; if it is really doing well, they think it best to let well alone without telling you.

I would advise all determined speculators to spread their investments over several concerns, and thus approach to an average. A sum of money distributed over five or six well-selected mines, could scarcely altogether fail of producing something.

Having given some account of a few wonderfully fortunate changes, I should, perhaps, be chargeable with one-sidedness if I did not add a specimen or two of the reverses altogether for the worse which have occurred in Cornwall.

Let us return for a few minutes to the district of St. Michael's Mount. I was thinking of the ruinous reverses in that district as I sat musing on the summit of the tower.

The mines of Marazion have presented a series of disasters. Against the good fortune of Mr. Treffry with his Fowey Consols, let us place in a few words and figures the mishaps of Mr. Thomas Saunders Cave in

THE MARAZION MINES.

Mr. Cave worked the principal mines in this district more than twelve years ago. They consisted of Great Wheal Fortune, Rospeath, Wheal Bolton, Owen Vean, Wheal Prosper, Wheal Friendship, &c., all being on branches of the same Great Champion lodes, and Gwallon, on parallel lodes to the south. The total loss of Mr. Cave on the twenty-seven mines amounted to £192,722, 14s.! Look at a few particulars.

Great Wheal Fortune was worked by the great-grandfather

of the late Sir Charles Lemon, Bart., and gave a profit of £100,000. During the working of Mr. Cave, it yielded ores to the amount of £50,000, but, owing to the extravagant outlay, was abandoned with a loss of £29,658, 11s.

Rospeath had been worked for copper to a depth of fifty-seven fathoms. The lode was a continuation of that in Great Wheal Fortune. This mine yielded ore, but was abandoned with a loss of £15,637, 18s.

Wheal Bolton is separated from Rospeath by a very large cross course, and the mine had been worked for copper to about eighty fathoms under the adits of seven fathoms. There were two lodes, which, dipping different ways, were heaved the same way by a cross course. The loss on this mine was £15,637, 18s.

Gwallon is forty fathoms under the adit of fifteen fathoms, and is a very old tin mine. On this mine Mr. Cave's loss was £16,485.

Owen Vean was worked in 1750, and left large profits. Mr. Cave's loss upon it was £22,234. Wheal Prosper (unlucky name !) was abandoned with a loss of £23,804.

It should be added, that the whole of this district is not to be considered ill-starred. Some of the Marazion mines—namely Wheal Virgin, Wheal Maid, Rodney, Crab, and Regurtha Downs, left a profit at an old working of £40,000; and were resumed about twenty-eight years ago. From the year 1831 to 1841, they returned ores to the amount of £150,000, but were soon abandoned at a loss. Wheal Crab, at the western part of these mines, where a valuable discovery was made, and an engine erected, had been resumed under the name of Chippindale, in compliment to a London gentleman of that name, and was said to be in a fair way of making a profitable mine; both tin and copper ores occurred, and, down to October 1842, it had returned 114 tons of copper, yielding £700, 7s.*

HINTS TO SPECULATORS AND INVESTORS IN MINES.

It is very seldom that you can get much information on the losses of mining. These are only known publicly when they

* Watson's Compendium of British Mining.—London, 1843.

occur on a large scale. Generally they are concealed; for not only do people refrain from talking of their losses, but few care to confess that they have had any thing to do with mining. A city friend of mine, who is deeply interested in some Cornish mines, remarks, that he scarcely meets with a speculating capitalist who has not at some time or other had a share in mining risks. If they have lost, they think silence covers their imprudence—if they have gained, silence covers their hoards. But, on the whole, most adventurers will be found to have lost, if they have not been real mining judges, resident on the spot, or connected intimately with those who are.

As to gambling in mining shares, what has been so largely said on gambling in railway shares applies equally to mining. I give no advice to gamblers, except to get out of it. They deserve to lose, and will meet with no pity. But *bonâ fide* investments in mines are of a different character, although it is difficult to draw the distinction. No man, however, who wishes to invest in mines should do so without deliberate study of the subject. He should really understand a little of the nature of mineral veins, of lodes, and the singular accidents which may befall them—of mining machinery and labour, and the perils of a rise in wages or a fall in copper. This is a period of renewed speculation in mines, and hence I have thought it right to afford the above particulars; and also to append the few following brief hints, merely to put the unwary on their guard. It is not always that men fall in with honest and trustworthy agents and share-dealers, though several such there are.

Considering the great ignorance of three-fourths of the investors in mines, I shall be doing them a signal service by compressing much experience into the compass of a few hints. If such persons will study and obey those hints, they will not be likely to be great losers.

1. Use great caution when a mine is represented as being capable of being commenced without machinery; or as being able to be wrought with an unusually small amount of capital.

2. Refrain from any mine proposed to be wrought by steam machinery with less capital than £5000, unless you are fully

satisfied by your own *personal* examination. No mine ought to be undertaken without the possible resource of a surplus capital. Nine out of ten mines which have been cramped for capital, have failed.

3. Be cautious when the Purser of the mine is a trader or shopkeeper. Mining capital is useful to extend private trade. Look to the Purser well, lest he look to himself too well; lend to him personally rather than indirectly.

4. Resident shareholders sometimes take shares in a neighbouring project, if it will drain their own mine of water accumulated in it. Beware of projects got up by such gentlemen.

5. Avoid mines of which the traders in supplies have the agency, or in which their special friends are strong and numerous.

6. Avoid mines belonging wholly to non-resident shareholders, and which are left to the unchecked control of the Purser and Captain.

7. Look well to the registry and transfer of shares, if entrusted to the Purser alone, by means of entries in the cost-book only.

8. Avoid mines of any metal except tin, the leases of which are incomplete, or have never been granted except by the sett and signature of the lord's agent in the cost-book.

9. The repute, skill, and character of the Purser and Captain of the mine you invest in, are quite as important to you as your skill in your own business.

10. Reference to an agent of uncertain character sometimes leads to a depreciation in the concern *you* are thinking of, and a recommendation of the concern *he* is thinking of.

11. What exactly suits the views of a mine agent, may not exactly suit yours.

12. It is far easier to put tin into a mine, than to get tin out of a mine; and it is more likely that you will lose £100 than gain £10.

13. To determine the number of shares you will take in a very promising mine, first consult your wife, then count your children, and lastly, calculate your household expenses.

14. It is just possible that the sample ores you see in London, or some other city, have come from any mine except the one projected, or offered to your consideration. Some samples have been known to serve for several mines.

15. As to foreign concerns, beware of wonderful reports and astonishing specimens. Not long since, some most rich masses of copper were exhibited in London, and a company projected. A keen agent being sent out to report, found no such wonderful masses of copper, and hinted that more specimens had been *brought* to the spot by the hand of man than the hand of nature.

16. Before you invest, do not look over a list of mines whose returns have been extraordinary; but reckon up the failures. Be sure to be particular about these, as they will most concern you.

17. When you have invested, make up your mind to lose; and then any gains will be clear gains, and pleasant disappointments.

18. Send the author a ten-pound-note for his advice—good in either event!

A SPECULATIVE ADVENTURE IN MINING, BY WAY OF EXAMPLE.

Examples profit more than precepts, is an old and approved maxim. Let, then, the reader take an example from the veritable history of an individual known to, but not, the author. Reader, if you are disposed to speculate in mines, ponder the following course of my friend, Jonah Jenkins. To bring it known to you more pointedly, I will put you in Jonah's place.

You are a middle-aged man, in a decent way of business in the city, No. 19, Hugger-mugger Lane. You have taken apartments (being a bachelor) in Vassal Road, Brixton. You are continually riding on the omnibus with a large made, dark gentleman, say about fifty-seven, of somewhat bloated appearance, but looking and speaking very benevolently. You find he lives close to you, in one of those comfortable-looking houses with a good garden behind, and a strip with an iron rail-

ing before. You are always meeting and riding together, but don't feel familiar enough to call. You know his name, Andrew Teague, Esq., of No. 16, Vassal Road. You meet his two daughters every Sunday and every fine summer evening, but you don't like to speak, as they do not speak or simper to you. As to his two sons, they are rough, racketing fellows, and you wouldn't care to know them at all. Things might go on this way for years, but your old grandmother in Buckinghamshire dies. She leaves you less than you had a right to expect, but you put on mourning for her, and this leads Andrew Teague to address you in a few words, but clumsy words, for he has lost several teeth—"I trust, sir, you have not lost a near relation?" "Thank you, sir, only a grandmother." "Happy to see you, sir, at any time at No. 16; pray, call in to-morrow night, we shall have a few friends." You call, and thus commences your fatal friendship with the Teagues.

After supper, Teague talks very familiarly with you. He hopes the grandmother has left you a fortune. "No," you reply, "only a trifle, only in fact" (for you have had a few glasses of Teague's sherry), "only £3000." "Well, even that if judiciously invested may yield a man a snug little income. Why, let me see, £3000 in Wheal Bundicks would bring in £460 per annum." You assent, with evident constraint. "Pray," rejoins Teague, "if I am not too prying; how do you mean to invest that money?" "How?" say you, "why, in Consols to be sure, nothing else safe that I know; or else in mortgages." "Humph! in Consols it brings about £100 per annum, and, if you want to sell out again, you lose perhaps some hundred or two pounds. Look at this—ten per cent. fall since the Russian panic. That would leave you just £300 minus on the £3000." "Well, then, there are mortgages." "Yes there are, at four or five per cent., with infinite bother, much ado with lawyers, mortgage deeds not ready for a month or more, plague to get your interest to the day, and the chance of taking a bad security; not to mention the fact, that any day your principal may be returned to you, and you left to seek a fresh mortgage." "Well, then," you put in, "there are railroads —what do you think of Great Westerns?" "Great Westerns!

my dear sir, I would not hold them—not worth a dump. They pay dividends out of capitals, and spend profits on lawyers and engineers. There's Brunel; I know him well, a clever little fellow. I was travelling with him when the line was forming. 'Brunel,' said I, 'this will be an enormous expense.' 'True,' said he, 'but that does not belong to my department.' He is the man that pockets a large slice of the real dividends, and the directors the remainder. Then there's Stephenson and Bidder; ah! I know them well, and what they have pocketed too."

You are driven into the corner of your chair. "Take another glass, Jenkins. Happy to see you; hope to see you very often; step in whenever you like. Glad to see you in the city any day. Here's my card." And forthwith, together with the decanter, you receive the following card:—

TEAGUE AND SNEAGUE,

MINE AGENTS AND SHARE DEALERS,

No. 6, COPPER COURT.

You go away with the conviction that Teague is a very knowing, and withal friendly fellow. As to his sons you have exchanged but few words with them—noisy, blustering, shirt-studded fellows; but as to his daughters, though the elder is rather more than young, the younger, Maria, is a very sweet girl, with blue eyes and fair hair, and smiles as charmingly as if her father had never been in Copper Court, or bought and sold a single share in a mine.

You are in the city one fine day, having been at Doctor's Commons about that old grandmother's will. Yes, she ought to have left you the whole seven thousand; but then those snivelling, crouching daughters of Jackson, they paid her such court every day, and flattered her to the eyes. Well, once more to Hugger-mugger Lane; but, lo! here you are at the corner of Copper Court! Easy thing just to step in and see that friendly fellow, Teague. Where can No. 6 be? Oh, here! Look on the door sides, and true enough you see, "Teague and Sneague, first floor." You mount in the dark, and over a pane of ground glass in a dark door, you see "Teague and Sneague" once more.

In you go. "Is Mr. Teague at home?" From behind a high-railed desk out steps Teague. "Ah! Jenkins, most happy to see you; let me introduce you to my partner, Silas Sneague." Out from another high-railed desk steps Silas Sneague, a very different man from Teague, being rather small, much perked up, and very stiff in high collars, and dashing in a short trim frock-coat.

"Very happy to see you, sir, and to make your acquaintance; have heard of you from my friend, Teague. Sorry for your late bereavement, sir; a grandmother, I believe?"

"Yes," rejoined Teague, "but she has left him a *souvenir* in the shape of £3000. By the by, Jenkins, have you invested that yet?" "No, Teague, for the good reason that I shall not have it for a month, and then I don't know what to do with it, after what you said. It would be a great risk to put it in mines, I suppose?" "Not a great risk, Jenkins; true, there must be *a* risk in all such very profitable specs, but I could find you improving concerns, where you would be pretty sure of ten or fifteen per cent. per annum. Why, now, here's Wheal Dandy; it *has* been a first-rate concern, and they only want £60,000 to put it in full working order again. Shares are to be bought low just now, because money is tight, and several of the holders are weak, timid men, but I believe you will not get them in six months for thrice their present price. Then here's Wheal Samson, a most promising concern, if you prefer it. I have forty shares for sale from a bankrupt—at least he will be so, I fear, shortly. He told me he would not sell otherwise for thrice the money—a capital spec; on the cost-book principle, and dividends payable every three months in London. Many of the shares are held by moneyed men who won't sell. Sir Jonah Jobson holds a hundred I sold him at 5, and they are now 9. In six months they will be 20 or 30. However, I never advise any body to have any thing to do with mines. A man must be a bold, prompt fellow to make any money of them. Timid men always lose—Jenkins, I never advise."

"Well, Teague, I am a timid man; but you seem to have an excellent knowledge of mines, and I am sure you would not

mislead one, so I will just take a few shares in Wheal Samson, to see how they turn out; I will take twenty, if you please." Teague turns half round and exclaims, "Mr. Sneague, just enter to Mr. Jenkins twenty Samsons at 9, for account on the 15th, and please to hand me the ticket of sale. Jenkins, please to be here on the 15th with your cash—good-morning—glad to see you at Vassal-road, the girls will be always happy to give you a little music."

You descend into Copper Court, the fortunate possessor of "twenty Samsons at 9," cash for shares on the 15th. On the 15th you get your shares and give your cash. You have studied a mining share-list in the mean time, and are astonished at the large returns from some mines for a mere nothing of paid-up capital. If you could but get into one of these mines, or one of that kind, what a nice income you might receive! Next Sunday you pass the Teagues at church; on coming out, how sweetly Maria smiles on you! Ah! if you were but in one of those wealthy, immense profit-making mines, why then, perhaps Maria—but nonsense, you can do nothing upon £3000 at a mere 4 or 5 per cent!

One dull evening Teague presses you, as you get out of the omnibus together, to step in and take tea with him. You are but a bachelor, what does it matter going home first? You enter 16, Maria smiles again; blue eyes and fair hair in an English girl are very pleasing. You play at chess, you sing, and in three months you are a frequent and welcome visiter at Teague's. Which do you think most of, Maria Teague or Wheal Samson? It is difficult to decide, when the latter is declared to pay a dividend of 12½ per cent., with the best prospects of increase. "Didn't I tell you so?" exclaims Teague. "You had better buy in while you can; that mine will be a fortune in a year or two. Captain Tregelles told me the other day, he thought that the North-west lode would turn out one of the best in Cornwall. He is sure of a bunch of ore."

You call again at 6, Copper Court. You are undecided, and sit ruminating there on an old chair, glancing at the piles of rough wooden boxes in the corner, which hold specimens of ores from all sorts of mines. Some are lettered, "Willy Nilly Coppers;" some, "Derbyshire Leads;" some, "Wheal Buller;"

"Wheal Cupid," and "Tresky Consols;" and just two from the top you read, "Wheal Samson." Sneague presents you with a bit of the ore—it is very heavy and full of copper, say twenty per cent. In steps a shrewd, roughish-looking man, who is introduced to you as Captain Tregelles of Wheal Samson; the result of whose conversation is, that you buy all the shares you can get that day for £17, 10s. per share, for the account on the 31st. On that day you return from Copper Court laden with Wheal Samson shares, and expectant of dividends. I am bound to state that you are now more frequently found at Copper Court than Hugger-mugger lane during the day; and, during the evenings, more frequently at 16, Vassal Road, than at your apartments at No. 7; all the natural consequences of your interest in mining. Another three months brings you a dividend of 12½ per cent.; and now they are sure never to fall below this figure. You think of investing the whole of your £3000 in Wheal Samson; Teague says you cannot do better, or so well, only he never advises any one to have any thing to do with mines. Tregelles has told you he will be happy to see you at any time in Cornwall. Before you invest all, being a timid man, you will go down and see Wheal Samson for yourself. It is passable weather, and down you go. You find the captain in a humble cottage near the mine, taking beer and pilchards, he being only a mining captain; but he gives you a hearty welcome. You spend a week in inspecting the machinery, the surface works, the whole processes of spalling, buddling, jigging, &c., and you take the greatest interest in the whole, knowing how many shares you have in the concern. All treat you with civility and respect. You at length spend some hours under ground with Captain Tregelles. You do not wish to go down again, having been so knocked about, and defiled, and battered, that you really know little more than you knew before. True, you have seen the ore in the lode, having broken a bit off with a pick for yourself, and have gained some very much moderated notions of the beauties of a mine. The captain shows you how the lode is likely to grow richer and richer; how he has some idea that they are on the eve of a capital discovery; and how

and why he thinks it will suddenly spread out into a very rich *bunch* of ore. He is deeply learned in lodes and cross-courses, and the promises of lodes. He explains to you all about elvan, and killas, and cross-courses, and heaves, and slides, and after the whole you think yourself a skilful judge of mines.

You return to town, pondering gravely on the propriety of investing all the old grandmother's legacy in Wheal Samson. As a timid man, you still hang back, and will wait until the next dividend; that comes, with 15½ per cent.! Now, there can be no doubt. The shares are at twenty-three, and buyers at the price; seize the moment! You hasten to Copper Court; Teague approves; Sneague fears you cannot get so many shares *now.* Holders are very strong; Wheal Samson is the fancy of the market. But he will try. After great efforts, and many inquiries, Sneague furnishes you with two-thirds of the number you want. And now you have invested in Wheal Samson £2742 : 10 : 4.

You are now in high favour with Teague and Sneague, and invited to their annual business or customers' dinner, at the King's Head, Poultry. Maria Teague may yet be Maria Jenkins. But let us conclude the whole, and not dwell on what is melancholy. After one more dividend, a *call* is made for machinery; or, water is increasing in the mine. You meet the call with much difficulty; but who would sell now? You will do better, says Teague, after the next dividend. Alas! it never comes—never to you; but suddenly the lode fails, instead of coming to a bunch. The water only does *not* fail. In a few months Wheal Samson is a losing concern, and then stops! Your whole shares are now worth just £346 : 10 : 3, and no buyers at the price! Teague never advised you to have any thing to do with mining. Sneague thinks that other failures have been as bad, and that the shares may rise again when the water sinks. Maria has a cold, and cannot sing; or a headache, and cannot appear. Teague is sorry he can't ask you to stay this evening; he is busy with share accounts, and expects to be for some time. The sons boldly cut you; Hugger-mugger Lane

affairs are on the verge of ruin. Finally, Teague drives past in a neat carriage with his daughter, one fine evening, just as you are preparing to sell off all, and go to Australia! A true history this, as Jenkins himself could tell! Need I say, trust not in Teague or Sneague, or Tregelles or Maria, or Wheal Samson?

CORNISH MEN AND MANNERS.

The Cornish men are divisible into three great classes—the agriculturists, the miners, and the fishermen. Those who profit by the surface of the earth—those who profit by the depths of the earth—and those who profit by the depths of the ocean. The last census shows the number of inhabitants to be 341,269, living upon a space of 1327 square miles. This proportion between space and inhabitants, gives a result considerably below the average population of a square mile throughout England. Therefore Cornwall does not labour under a superabundance of population, but the supply about equals the demand, except for reapers at harvest time, and for any sudden emergency. The remoteness and general character of the county prevents any influx of competing labourers.

Emigration, too, has tended to keep down the Cornish people as much as any other in England. The potato blight blighted the hopes of many, and sent them abroad. In 1849, nearly five per cent. of the population of the Penzance Union emigrated to Australia or New Zealand. Vessels from Fowey to Canada convey many emigrants; and a young clergyman who accompanied us in our van, was going to embark at Fowey for Canada, because the passage-money was lower than from other ports.

The soil of Cornwall in many portions, particularly as you proceed westward, is far too poor to pay for much cultivation. The geological origin of the soil leads to very different degrees of fertility. The relative fertility of the granitic soil depends greatly on the abundance and easily decomposable character of the felspar in the subjacent rock; while much mica seems to make the soil poorer. At the junction of the granites and slates,

the soil is considerably improved, as may be seen in the vicinity of St. Michael's Mount. In the mining districts you only expect barrenness, because vegetation is destroyed by the operations on the surface; but, in addition, you find the soil in such situations covered by a thin bed of quartz fragments, composed of the parts of minor veins of that substance, which abundantly traverse these districts. Through the alluvial districts, and some few others, fertility may be expected. Manure, too, of sea sand and blown sand is extensively employed. Padstow harbour furnishes one-fourth of the sand employed for agricultural purposes in Cornwall and Devon; and, estimating the ton as containing fourteen cubic feet, we should have about 5,600,000 cubic feet of sand (chiefly composed of comminuted sea shells) annually conveyed from the coast, and spread over the interior as mineral manure. A very fertile soil is formed from what is geologically called "trappean ash," on the trap rocks; but, after all, Cornwall is not a county for agriculture, and therefore I say little more of agriculturists.

The fisheries not only employ all the inhabitants of the coast; but, in the pilchard season, also many of the farm-labourers as well. It will be supposed, therefore, that the fishermen, who form a considerable class in Cornwall—about 10,000 persons—derive their regular support from the Cornish fisheries. Where they are engaged in the pilchard fishery, as many of them are, their wages and gains are good for the length of the season. The "shooters," for instance, who cast the seine net, receive eleven shillings and sixpence per week, with perquisites. Often the fishermen have, in addition, small shares in a company of pilchard fishers; and altogether they may be considered well off in good seasons, such as the present one has proved to be. While I am writing, the newspapers give paragraphs stating the large hauls of pilchards at the chief Cornish sea-coast towns—as St. Ives, &c. Nor is the fluctuation between a good and bad season in fishing so great or disastrous as some might expect. Fishermen not engaged in the pilchard fishery, are of course not so well off, and much like others on other coasts. The "Drift," or deep sea fishing off Mount's Bay (near Penzance), is

often very profitable, and is estimated to realize on an average about £30,000 per annum.

Amongst the inhabitants of Cornwall generally, I have found as much civility and kindness and content as any where in Great Britain. Perhaps they show more courtesy to strangers than usual; and my companion formed a very favourable opinion of the females, whom he as a family man could well estimate. Domestic affection distinguishes the peasantry much more than education.

The natural affection of mothers for their children is seen pleasantly in the fishermen's and miners' cottages. I noticed the same amongst the northern pit-people. Such clamorous crowds of little urchins as I have seen in mining villages, proved to me that the "lode was promising," as a miner would say.

The primitive and simple habits which the Cornish labouring people retain, render a van or pedestrian tour among them very refreshing to the jaded inhabitant of cities and towns. I retain pleasant recollections of many of the working classes in most parts of Great Britain; but yet I would almost prefer a month's walk over Cornish scenes, or a month's sojourn amongst Cornish peasants, to the same any where else. Seldom overcharged amongst them for accommodation, I never received an impertinent answer that I remember.

Nor must it be supposed that such simplicity and courtesy imply ignorance. In spite of deficient education, I found much native shrewdness. One instance of this occurred in a boy on our travels. We were riding with the coachman of a kind of omnibus, which had to pass through a gate at a part of the road, which gate, not being turnpike, was commonly opened by any chance foot-passenger at the time. A stout, lazy lad stood by the gate, but would not open it. "Ah!" exclaimed a mean, close-looking, little man who sat near us, to the boy. "Ah! my boy, you have lost a penny." The lazy lad looked up, and scanned the parched features of the speaker, and replied very appropriately—"No, I ha'n't."

Nothing in the present race of peasantry indicates that wildness of ancestry which is pointed out by tradition and antiquarian

research. So far from this, you would imagine that their aboriginal progenitors must have been peculiarly gentle and pacific. Yet, as we learn, Cornwall was formerly inhabited by rude Britons, called Danmonii, and an old Latin poet,* who lived some five or six hundred years ago, speaks of certain giants who inhabited this, as well as other parts of our island, in lines which are curious, and which may be thus rendered:—

"Of Titan's monstrous race,
Only some few disturb'd that happy place;
Raw hides they wore for clothes, their drink was blood,
Rocks were their dining-rooms, their prey their food.
Their cups some hollow trunk, their bed a grove,
Murder their sport, and violence their love.
Their courage frenzy, strength their sole command,
Their arms, what fury offer'd to their hand.
And when at last in brutish fight they died,
Some spacious thicket a vast grave supplied.
With such vile monsters was the land oppress'd,
But most the farther regions of the West;
Of them thou Cornwall, too, wast plagued above the rest."

The English spoken by the educated Cornish is very good, nor are the labouring classes great breakers of proprieties of speech. Cornwall had a language of its own, somewhat akin to Welsh, down at least to the time of Edward VI.; and indeed this language continued to be spoken by the lower classes until about the close of the 17th century, and still gives names to localities, men, and implements. And this leads me to speak more particularly of

THE OLD CORNISH LANGUAGE, AND ITS REMAINS.

The Cornish language is a dialect of that which, until the Saxons came in, was common to all Britain, and more anciently to Ireland and Gaul. But the inhabitants of this island being dispersed before the conquests, and driven into Wales and Cornwall, and thence into Brétagne, the same language, for want of frequent intercourse, became differently pronounced and written

* Hauvillan, quoted in Camden's *Britannia*, Ed. Gibson, pp. 3, 4.

and in different degrees mixed with different languages. Hence came the Welsh, the Cornish, and the Armoric dialects, whose radicals are so much alike that they are known and admitted by the inhabitants of either county; while the grammar is so varied that they cannot converse. The Cornish is reckoned the most pleasing of the three.

It was spoken so generally in Cornwall down to the reign of Henry VIII., that Dr. John Moreman, vicar of Mynhinet, is said to have been the first who taught his parishioners the Lord's prayer, the creed, and ten commandments, in English. In some parishes, the older people retained their original language to the middle of the last century, and the last sermon was preached in that language in 1678. When Mr. Ray, the naturalist, was in Cornwall in 1662, he could find but one person who could write this language, and it is now so nearly extinct that, in 1768, Mr. Barrington could only find one old woman who could talk in it, and singularly enough she could only *scold* in it—a melancholy proof of human depravity; and that the last thing that dies away in a language is that which ought never to have found its way into it! I ought, however, to add, that the Lord's prayer is preserved in what is presumed to be ancient Cornish.

In Gibson's edition of Camden's *Britannia,* p. 18, the Lord's prayer is given in Cornish, Welsh, and Armoric, which three tongues bear a remarkable similarity. The first clause of the Lord's prayer is thus read in Cornish—"Ny Taz ez yn neau, bonegas yw tha hanaw." To this also is appended the creed in Cornish. One reason which Gibson states for the decay of the old Cornish, is the giving over the great conventions of the people, called *Guirimears,* i.e., *great speeches* (perhaps now transferred to the House of Commons!) which were formerly used, and which consisted of Scripture histories, &c. They were held in the spacious and open downs, where there were earthen banks thrown up on purpose, large enough to enclose thousands of people, as appears by their remains at this day.

A place called Piran Round, not very far from Redruth, was traditionally a principal theatre for the ancient Cornish conventions and dramatic mysteries.

Three books in Cornish are all that can be found, according to Gibson, who does not say where, but only :—" One is written in an old court hand on vellum, and in 1036 verses contains the history of the Passion of our Saviour. It always has *Chrest* for Christ, according to the ancient Roman way of writing *Chrestus* for Christus, (as in Suetonius 'impulsore Chresto.') By the characters and pictures it looks something like the time of Richard III., and positively determines against Transubstantiation. The other two are transcribed out of the Bodleian Library (at Oxford). One is translated, and the other is now translating, by Mr. Keigwin, the only person, perhaps, that perfectly understands the tongue." *

THE ANCIENT CORNISH DRAMA.

This reference conducts us to that precious relic of the ancient Cornish drama, which Mr. Gilbert corrected and republished in 1827. It is entitled "The Creation of the World, with Noah's Flood." It was translated in 1611 from a drama of much earlier date, by William Jordan, an English poet, for performance in Cornish. John Kegwyn, or Keigwin, rendered it into English in 1691; and this drama Mr. D. Gilbert republished, placing the ancient Cornish and the English on opposite pages.

As a relic of the past this play is very curious, written in a rambling eight-syllabled measure, interspersed with longer and shorter lines, and sometimes with a word or two of English. It is composed in five acts, and occupies 180 pages, each containing an average of twenty-five lines.

In the first act we are favoured with the company of the whole Heavenly Host. In the second we gain the addition of Adam and Eve, a devil called Torpen, Beelzebub the serpent, and Michael the archangel. The third act brings in Death, Cain and his wife, Abel and Seth. The fourth adds to the com-

* Some clever imitations of the low language of the mining districts have been published, in which old terms abound; but it is difficult to distinguish what is due to vulgarity from what is due to antiquity. None of the imitations appear to me to be worth quoting—though they interest Cornishmen.

pany Lamech, a servant, and a first and second devil. The fifth provides us with Enoch, Noah and his wife, Shem, Ham, Japhet, Seth, Jaball, and Tubal Cain.

The author is not fettered by any of the old Aristotelian rules, and unities of time and place seem to trouble him not at all. A skip over a hundred years costs him no effort, and a matter of bad theology no kind of compunction. The stage directions as to ornaments and scenery display a better notion of propriety than the actual drama, as may be gathered from the following orders as to the getting up of the garden of Eden:—"Let Paradise be finely made, with fair trees in it, and apples upon a tree, and other fruit on the others—a fountain, too, in Paradise, and fine flowers painted—put Adam in Paradise—let flowers appear in Paradise—let Adam lie down and sleep where Eve is, and she by the Conveyor must be taken from Adam's side—let fishes of all sorts, birds and beasts, as oxen, kyne, sheep, and suchlike, appear."

Then come the directions for the exhibition of the Temptation:—"A fine Serpent to be made with a virgin's face, and yellow hair on her head—let the Serpent appear, and also geese and hens." Now Lucifer enters and goes into the Serpent, which, it is then ordered, must be "singing in a tree." The result of this singing with a virgin's face and yellow hair is fatal—for "Eve looketh strange at the Serpent, and then "talketh familiarly and cometh near him;" afterwards she "doubteth and looketh angrily," and then eats part of the apple, shows it to Adam, and tempts him to eat part of it too, in the following lines, which will serve to show that the author knew something of the character and power of feminine arguments:—

> "Sir, in a few words,
> Taste thou part of the apple,
> Or my love thou shalt lose!
> See, take this fair apple,
> Or surely between thee and thy wife
> The love shall utterly fail
> If thou wilt not eat of it!"

The original Cornish of the above lines will be regarded as a curiosity:—

"Syr, war nebas lavarrow,
Tast gy part an avallow,
Po ow harenga ty a gyll!
Meir, Kymar an arall teake,
Po sure inter te ha'th wreage
An garenga guyt a fyll
Mar my vynyth y thebbry."

This can scarcely be taken as a fair specimen of ancient Cornish; for at this period it had begun to change, and to become English to a small extent, as several of the above words show. The Latin words in the fifth line, "inter te," were probably a specimen of ancient Cornish pedantry in the year 1611.

I shall not proceed with the development of the plot or the play. It is well worth a curious reader's attention. I will only add Mr. W. Collins's graphic description of the imagined scene:—"To see the play, must have been a sight indeed! Imagine the commencement of it; the theatrical sky, which was to spin awfully when heaven was named; the mock clouds, coolly set up by the 'property man' on an open air stage, where the genuine clouds appeared above them to expose the counterfeit; the hard fighting of the angels with swords and staves; the descent of the lost spirits along cords running into the plain; the thump with which they must have come down; the rolling off of the whole troop over the grass to the infernal regions, amidst shouts of applause from the audience as they rolled. Then the appearance of Adam and Eve, packed in white leather, like our modern dolls. The serpent, with the virgin's face and the yellow hair, climbing into a tree, and singing in the branches. Cain falling out of the bush when he was struck by the arrow of Lamech, and his blood appearing, according to the stage directions, there when he fell; the making of the ark, the filling it with live stock, the scenery of the deluge in the fifth act—what a combination of theatrical prodigies the whole performance must have presented! And how the actors must have raved to make themselves heard in the open air; how the machinery must have gone wrong, and the rude scenery toppled and tumbled down! The end of the play, how picturesque and striking all the circumstances attending it must have been! Oh, that we could

hear again the merry old English tune piped by the minstrels, and see the merry old English dancing of the audience to the music! Then think of the separation, and the return home of the populace at sunset. The fishing people striking off towards the seashore; the miners walking away further inland; the agricultural labourers spreading in all directions, where cottages and farmhouses were visible in the far distance over the moor; the darkness coming on, and the moon rising over the amphitheatre, so silent and empty, save at one corner where the poor, worn-out actors are bivouacking, gipsying in their tents, cooking supper over the fire, that flames up red in the moonlight, and talking languidly over the fatigues and triumphs of the play." Such is a restoration of the ancient drama, the open amphitheatre, the actors and the spectators at Piran Round, in Cornwall, in the year 1611!

What number of ancient Cornish words the *patois* of the Cornish miners now retains, it is impossible to say. Possibly, many of the terms connected with mining belong to the ancient dialect, but most of them may have sprung up from odd associations. Yet there are some for which it is difficult to account otherwise than by referring them back to the ancient tongue. Such terms as *bal*, the miner's term for a mine; *attle,* for rubbish, or refuse of stony earth; *costeaning*, for discovering lodes by sinking pits in their vicinity, and drawing transversely to their supposed directions; *growan*, for decomposed granite; *kal*, for hard; *para*, for a gang or party of men; *van*, to wash or cleanse, and thence *vanning*, for removing impurities from ore; *vugh*, or *vogal* for a cavity. These, and other like terms, appear strange to the English language. I might add the words "bryle," "chats," "terluing," "dzhu," "polroz," "zyghyr," and others.

MINERS IN AND ABOUT THE MINE, AND AT HOME.

If you can get up before the Cornish miners, you may see all the cottages, scattered over a populous little district near the mines, quiet and dull enough in the grey morning. Soon, how-

ever, the scene becomes very animated for this part of the county; and, if you stand on an eminence, you see, as far as the eye can reach, men, women, and children of all ages, beginning to creep out of low cottage-doors. You watch their course, and observe that, after various windings, all begin to converge towards one spot, and that one spot is the mine and its shaft. To that entrance the old men walk direct and grave, while the maidens and boys skip or move towards it more indirectly. On their arrival at the mine, each set diverge to their different tasks; the women and children to the rough sheds under which they work at the surface-work of the mine; while the men retire into a house, and having stripped, put on their underground clothes, composed of coarse flannel, and generally much the worse for wear—

> "Let us look at him now:—prepared to descend,
> His partner he joins, and it may be his friend;
> Nor silent are they, for the sweet hymn of praise
> Is sung down the ladders, through levels and ways.
> For though dangers surround and darkness prevails
> On all things except what the candle reveals—
> The gloom is without, nor exists it within,
> With peace in their hearts they fear only Sin."

These underground miners now begin to descend one by one, not in threes, fours, and fives, as in the northern coal-pits, but one by one, as they generally descend by long and numerous ladders. Where they descend by the man-machines their journey is easy both down and up; where by ladders, it is a sad prospect for them both in going in and returning. They don't waste many words; for they are men bent upon grave matters in dark places, and, as many of them are Methodists, you hear little or no swearing, and sometimes, on the contrary, a line or two of a favourite hymn to a stave or two of a familiar tune. A very short space of time serves thus to separate fathers and brothers from sons, and daughters, and sisters. The last man disappears, and these children are working heartily above ground, while their husbands, and fathers, and brothers, are blasting, and hammering, and picking, thousands of feet below them!

If a desolating war or conscription had devastated this part

of the country, there could not be a greater scarcity of able-bodied men than there is now that mining work is fairly commenced. Nor indeed will you find many women or children away from the mine at present, unless you penetrate into cottages and sick houses.*

Now a remarkable deadness prevails all around. The tall chimneys of the steam-engine emit no smoke, and nothing is in motion but the great *bobs* or levers of those gigantic machines, which, as they slowly and solemnly rise and fall, exert their power either to lift the water or produce from the mine, or to stamp the ores. Man—the lord of the earth—is now at this spot much below the cattle, who are lazily browsing or ruminating on the scanty surface, under the open influence of sun and air, while their natural master is toiling away in far, deep darkness, and rocky seclusion.

The distance he goes underground, and the places he continues to work in when he arrives at his "pitch," are known to few besides the Cornish miner himself. A practical miner can work in a level 600 feet from a shaft without inconvenience, if there be good ventilation; but men have been known to lose five pounds or six pounds of weight at a single "spell" of labour, from profuse perspiration at the bottom of a deep mine, where the temperature is often nearer 90° than 80°.

Much time, as well as strength, is lost to the poor miner by the length of his journey before he arrives at his place. So deep are some of the mines, that it requires an hour to reach the surface after the man's work is finished for the day. Very few persons have any idea of the extent and magnitude of one of the large old Cornish mines. An idea may be formed from the Consolidated mines, which extend no less than 5500 fathoms, or in plain measure sixty-three miles under ground. I have mentioned that the Killingworth collieries, near Newcastle, have nearly 160 miles of gallery excavation (*Our Coal*, &c., p. 132.)

* I may here notice that the late census has enabled us to trace the increase of population in this as well as other districts, for the last half century. In seven Cornish places connected with copper and tin works, namely, Helstone, Camborne, Redruth, St. Austell, Illogan, Gwennap, and St. Just, we find that the population in 1801 was 23,970, while in 1851 it had increased to 60,200.

To assign and distribute all the miners to their places, and to collect them all again at the surface, is a work of time and labour, in addition to the actual work in the mine—a work of more time and toil than that of collecting all the Joneses, Smiths, Davises, and Browns, for any Peckham or Clapham omnibus.

THE YOUNG PERSONS EMPLOYED IN AND AROUND MINES.

From the reports of commissioners I learn, that of the 30,000 persons generally reckoned to be employed in and about the Cornish mines, there are about 19,000 men and 11,000 women and young persons. "Young persons" have been defined to be males and females of from thirteen to eighteen years of age, those above and below such limits being adults and children. Dr. Barham* ably conducted an inquiry into the condition of the young persons and children in and around Cornish mines, and reported in 1842. From his valuable Report we learn, that of about 7500 children and young persons, about one-sixth were employed underground, and five-sixths aboveground; no female of any age being employed underground. Boys begin to be employed underground at ten or eleven years of age, while boys and girls begin the easier surface works about their seventh or eighth year. The Act of Parliament (5 and 6 Vict. c. 99), founded on the inquiries of the mining commissioners, limits the age for underground employment to ten years. The underground boys are usually employed by the men for the whole of each two months' contract; but in particular situations, for occasional services, they are passed from one party to another, and at times leave underground for surface work. Only a few boys are directly employed by the owners of the mine. When the boys are strong enough, the tutmen and tributers take them into partnership, instead of

* At the same time that Dr. Barham was thus engaged, Mr. Leifchild was reporting on the north of England collieries and lead mines, and general manufactures.—Both Reports have been found serviceable.

paying them regular wages—in such a case a boy is reckoned half a man, or three quarters of a man, bringing to our recollection the curious terms for boys in the northern collieries, "Half marrows and foals." No apprenticeship exists.

The underground boys work the air-machines, or are employed in wheeling barrows, in pushing teams, and in holding and turning the borers. The air-machine is a curious kind of water-bellows, consisting of two boxes or cisterns, one being inserted within the other, which is filled with water. The boys also aid in removing the ore and rubbish by working windlasses to draw it up the shafts, or rolling it in barrows along the levels, or pushing small waggons on an iron tram-road, like the "putters" of the Newcastle coal-pits.

When they go down to work, they put on a loose woollen dress, thick shoes without stockings, and a strong hat with a convex crown, weighing from one to two pounds, and preserving the head like a helmet from blows and falling bodies. The hat commonly bears a lump of clay holding a lighted candle. On returning to the surface, the underground garments are hung up in a suitable building.

In the above-ground works, which I have previously described under "A Mine in the Moors," &c., the child, boy, or girl, is introduced by a parent, with a request for work, the wages at first being twopence or threepence a day, and gradually increasing. The surface children work about ten hours a day in summer, and nine in winter, with usually a meal-time at noon, of half an hour in winter, and a whole hour or less in summer. In some of the large mines sheds are provided for the children to dine under; but they often huddle into a smith's shop, or into the drying-room where the miners' clothes hang. In summer, the dining-table is the grassy slope of a neighbouring hill, or a clean spare part of the dressing-floors. Boys and girls form separate groups, each enjoying a game of play as a dessert after dinner. The wages vary from two to four or five shillings a week for the more expert children, and thus there is enough to keep in part or whole each child. The earnings are not reckoned weekly, but the pay-day is once a month, the children being paid by the

mine clerk, and generally handing over the wages to their parents; pay for over work or extra work being kept as pocket money. Their food consists of potato pasties, sometimes with some pork or meat; and they have "hoggan," viz., a coarse kind of cake, composed of potato pieces and raisins, in a shell of baked dough. The mines differ in their accommodations, some having ovens, or a long heated cylinder, for the comfort of the work people. The girls have their ankles protected by thick woollen bands in winter.

I shall speak of their Sunday appearances under another head.

COLLIERS AND CORNISH MINERS CONTRASTED.

Before the miners come up, consider the points of similarity and contrast between them and the coal-miners of the northern collieries. Both work about eight hours on the average, deep down in mines. Both labour there under peculiar difficulties. Both are a somewhat peculiar race, brought up to the work, and seldom changing for other work. Both are confined closely to the spot, and inhabit, if steady men, the same cottage for a number of years. But there are many points of contrast. The Cornish miners do not make such good wages as the coal-miners. At pages 185 and 186, of "Our Coal and Our Coal Pits," you will find a rate of wages given in the north, which is unequalled in Cornwall. Ordinary or regular wages for mining in Cornwall range from forty to fifty shillings a month.* Of course I exclude the "working on tribute," that is, the excavation of the metalliferous lodes for a per centage on the value of the metal raised, which kind of work may produce very little, or as much as six or eight pounds a month.

Taking the average, however, the Cornish miner, man or lad, obtains wages much inferior to pitmen and pit lads in the northern coal fields. Consequently, they fare very differently at table. The Cornish cottage has no "singing hinnies," or rich girdle cakes, and the table seldom groans under a joint of meat.

* For wages in detail, see analysis of Fowey Consols Mine.

Potatoes and pilchards form the ordinary diet; and therefore, if potatoes are blighted, and pilchards fail in any one season, the poor miners of Cornwall will be in danger of starvation. Ten or twelve shillings a week won't do much for them, and agricultural labour will only afford them about nine shillings a week.

The great advantage, however, of metal-mining over coal-mining is, the exemption in the former from explosions and disasters by the ignition of the fatal fire-damp, so frequently found in the latter. A Cornish miner can go into his mine without any fear of being blown up, however much he may fear tumbling down. The terrors of "bags," and "blowers," and "blashes" of carburetted hydrogen gas are unknown to him; and he has no fear of "goafs," and "wastes," and broken or firing Davy-lamps, and blasted limbs. He can sit at ease, and read or hear of explosions that have destroyed forty, or eighty, or a hundred and twenty souls in a few minutes. He has not lost a son by fire-damp, or a father by "after-damp." For him the mine is not peopled with the ghosts of the destroyed and the departed; and he has never yet been called to assist in excavating blasted bodies from exploded mines! Surely these exemptions are worth more than the difference of wages, though perhaps the Cornish miners would not think so.

The northern pitmen have small coal for firing nearly gratis; hence they have better fires than the Cornish miners, who have only turf; yet these have that turf for the trouble of cutting it from the vast tracts of common land which overspread the county. Some things, too, are remarkably cheap with the latter, especially the pilchards, a dozen of which may be bought for a penny. Vegetables, except of late potatoes, are abundant and cheap. Early potatoes, grown in May and June, are cultivated in considerable quantities, and are exported at high prices. The winter stock has been recently imported from France, Belgium, and Holland, in consequence of the blight in the home stock.

PHYSICAL CONDITION OF CORNISH MINERS AND LEAD MINERS.

As to bodily diseases arising out of their occupation, there is not much that is definite to complain of, though a good deal that

is indefinite. There is a disease called the miner's consumption. Dr. Barham states that in four varied mining districts, out of 146 deaths of miners, seventy-seven die from consumption, which in other cases attacks only thirty-three out of 134 persons.

A minute examination of all the returns that can be obtained, leads to the conclusion that the occupation of miners is really prejudicial to health.

The miners are reported to fall off before sixty years of age, and are said not commonly to attain that age. Those who live longer find their health infirm compared with other labourers.

In 1837, Mr. Lanyon published some researches into the diseases of Cornish miners and their duration of life. He formed a table of the average ages of 1101 miners working underground in 1837, as *men*, and paid as men. The aggregate of the years of all these miners amounted to 34,152, which gave thirty-one years for each individual. Mr. L. then pursued his researches and comparison with 174 labourers, whose average age was forty-seven years. On the whole, he concludes that there is a great difference in the average of the longevity of the miners and agricultural labourers, in favour of the latter.

Should the man-machines I have described be generally adopted in the Cornish mines, this alone will make in time a sensible difference in the miner's health.

Lead miners are subject to diseases arising out of their occupation, far more decidedly than any other class of miners. Some researches I made amongst them in the North of England, left no doubt upon my mind. Nor could any doubt be left after looking upon their faces. Poor fellows! they know full well what their fate is. Slow but sure, is the progress of disease with them. The disease to which lead miners are liable, is what is provincially called "being broken-winded," or "chronic asthma," or "chronic bronchitis," which generally terminates in "phthisis pulmonaris," or consumption. They are also much troubled with constipation. It appears that the average age at death by the Carlisle tables is sixty-one years, and this far exceeds the average age at death of the miners, which in one spot is forty-nine years.

There are sick clubs in most of the mines, towards the support

of which a small weekly sum is paid, and there is a mine barber, who shaves all the men for a trifle per week each. Such deductions bring down their net earnings, perhaps, to a range between ten shillings and fifteen shillings per week.

Many mine owners wish to consult the comfort of both their adult and young miners. At Dolcoath mine, some years since, the owners gave the miners the luxury of a little warm food during the winter months. They provided hot soup for the men and boys on coming up from the mine, giving, in three winters of three months each, 26,234 half-pints of soup to about 450 men and boys; and the expense averaged only £5, 10*s.* per month, viz., £1, 15*s.* for the soup, and £3, 15*s.* for the wages of the servers. Surely this example might be generally followed.

MENTAL CONDITION.

The superiority of the Cornish miner to the agricultural labourer may be at once inferred. The latter is confined by habit to a set task, and he cannot rise above his drudgery, held as he is in the net of a hopeless poverty. He is never thrown on his own resources in the progress of his occupation, and he goes through life as a mere human machine, performing exactly the same thing from youth to age, neither increasing nor diminishing his scanty stock of ideas. The only advantage he has is open air occupation and exercise, and therefore good, though lazy and lumpy, health.

But the miner is the reverse of all this. He is engaged mostly in work requiring the exercise of the mind. He is constantly taking a new "pitch" in a new situation, where his judgment is called into action. His wages are not the stinted recompense of half-emancipated serfship, but they arise from contract, and they depend upon some degree of skill and knowledge. In fact, the chances of the lode keep alive a kind of excitement, and foster a hope of good fortune that never altogether deserts the miner. If at all imaginative, he dreams in the underground darkness of becoming suddenly rich, and perhaps, while resting on his bed in his cottage, visions of a rich, glittering bunch of ore flit before

him through many a midnight, and he does not always think *his* dream will go by contraries, even when he awakes. He is a kind of subterranean stockjobber; and doubtless the excitement such gentlemen feel on the London Stock Exchange, in "making a price" of Consols or of North Westerns, is paralleled near the Land's End in the heart of the humble tributer or tut-worker. "Settling-day" is doubtless an equally anxious time for both kinds of workers.

Where people are so isolated as the Cornish men are, primitive modes of thought and superstitions will long survive. Thus the old horseshoe charm is believed in by the miners and others. It is supposed that the Evil Spirit can only travel in circles, and consequently that, whenever he reaches the two heels of the horseshoe, he is, as it were, brought to a stand, and can only retrace his steps.

Again, the miners are said to be afraid of whistling underground, believing it to be unlucky. To work on Midsummer Day or Eve, or New-Year's Day or Eve, is also unlucky; and an old author complains that the miners make for themselves more holidays than the church desires, and their profits admit.

It would be expected that odd fancies would be born in the dark corners of deep mines; and accordingly, when slight explosions take place by the bursting of hollow crystalline masses containing confined gases, miners believe that the noise is occasioned by the mining pursuits of the pixies or fairies.

We are told that at Tavistock, some years since, a miner, on breaking through a crystalline mass (the interior of which was formed of crystals of quartz and pyrites, and shone brightly), declared that "he thought he was in heaven." When asked how the mass of crystals resembled heaven, he replied:—"It was so beautiful, he could compare it to nothing else than a Jew's shop!"

From the absence of traditions as to the original peculiarities of the Cornish miners, I infer that they have always been a milder and more mannerly race than the northern pitmen. Forty or fifty years ago, the Newcastle collier was an oddity. What with his hair in long curls, or his tail of hair tied up with ribbons; and his fancy-flowered waistcoat, "or posy vest;" and his velveteen breeches, and his flowing knee-ribbons, and his

"clocked" stockings, and his round ribboned hat;—there never was, probably, such a dashing workman in any department of labour in this country. But you hear of nothing whatever of this kind as formerly prevalent amongst Cornish miners.

Neither in their furniture do you trace any such firm attachment to four-post bedsteads, and good eight-day clocks, and mahogany chests of drawers, as I found and have described in the northern colliers' cottages. Indeed there is nothing to distinguish a metal miner's house from any other of the same class and kind. As to games and sports of bowls, and donkey races, and cock-fighting, and dog-baiting, I never heard of any of them in the western mining districts. In these, too, you find few or no characteristic amusements at night. Music is welcome, and you may find a few local bands composed chiefly of miners, but they are not general.

I gave some instances of the peculiar fondness for mathematical studies amongst the pitmen. I found few or none such in Cornwall. Neither mathematics, nor any other branch of study, is fervently pursued there, and any instance of excellence in any one branch of science stands out as singular. I fancy, however, that there is rather more sincerity and simplicity of character in the West than in the North. The North shows rather more of the Scotch character, and the West of the British. The Cornish miners will, upon being questioned, readily direct you as you are travelling where to go; the northern pitmen first inquire whence you come?

GOING HOME AFTER WORK.

But let us now watch the men ascending from the mine after work. This is what they call "coming to grass," which does not refer to any animal propensity to graze, but simply to coming to the surface, which they always term "the grass." Up and out they come, one by one, like bees out of a great hive—only laden with any thing but honey! Observe them rising up out of different shafts, perspiring, dirty, and jaded. The remainder of his bunch of candles hangs at the bottom of each miner's flannel

jacket. Now they flock to the engine-house, where they leave their underground clothes to dry. They all wash themselves in the warm water of the engine-pool, and put on their decent daily "grass" clothes.

About the same time the grass-workers, the maidens and boys and women, have stopped work, and washed their faces. They now join their relatives, and all proceed homeward, past chimney, and heaps, and mining erections, and then across fields and commons, in different directions and different groups. The men look grave and fatigued, and speak little and curtly. The wives want to chatter, and must therefore chatter chiefly with one another, while the husbands are mute and moody. The lads talk and laugh, and sometimes stop and wrestle on a green soft spot, trying to practise the "Cornish hug," a famous wrestling manœuvre. The maidens will either blush or bluster, smile or scream, as circumstances render most appropriate and age inclines. The bigger boys advance *per saltum*, that is, by leap-frog. Little urchins of tiny growth stand on their heads, or tumble head over heels. Mothers scold them, and sisters tickle them. The group now grows smaller and smaller by diminution at every cottage passed. Finally, down they come to the last family and the last man, who, having to proceed farther than the others, seems like the weary survivor of a vanished race, until he also at last disappears under a low door, and all the scene is silent as at morn.

When the young people have supped, they are brisk, active, and out again. Somebody must fill the water cask, and wheel it in a light barrow to the nearest spring. Sundry duties of this kind must be performed.

If the miner's labour has not exhausted him, after refreshing himself at his cottage, and kissing and fondling his little ones, he cultivates his acre or two of garden and other ground, which he obtains from the heathy downs upon easy terms, on lease for three lives, at a few shillings' rent. Upon this he has contrived to build a cottage, oftentimes chiefly with his own hands, the stone costing him nothing but the labour of fetching it from the moor. Or it may be that he has only taken land for the growth

of potatoes, to cultivate which he pares the ground, and burns it; and rents a cottage at fifty or sixty shillings a year, with a right of turf fuel, which he cuts and prepares himself.

Many miners have tolerable gardens, and some are able to perform their own carpentry; while, if near the coast, others are expert fishermen, thus combining the crafts of getting ore out of the rock, and fish out of the sea. In the mining districts of the west, about Camborne and Redruth, the ground is literally sown with cottages, and out of each cottage issues a whole crop of children at the sound of any passing vehicle. I was always astonished at the crowds of yelping and crying children that swarmed round me as I paused in any mining village. There seemed to be as great an abundance of little bright eyes above ground, as of bright "eyes of the mine" beneath.

MINERS AT SEA.

The miner is often possessed of eminent personal courage. This is proved by the singular fact, that at least one-third of the crew of Captain Pellew's (Lord Exmouth's) ship that fought the gallant action with the *Cleopatra*, French frigate (the first naval action in the last war), were Cornish miners, who had never been at sea in a large ship before; and almost all on board were fellow-countrymen of Pellew. Osler, in his life of Lord Exmouth, observes, that Cornish miners are better calculated for seamen than any other class of men on land; and this because the discipline of the mine is scarcely surpassed in a ship of war, and the order and business of the mine compels even the lowest man to act continually with judgment, so that habits are formed of ready obedience, intelligence, promptitude, and intrepidity.

In the action above named, about eighty miners entered for the ship called Nymph, and joined her at Spithead. In the courage of his men Captain Pellew placed the firmest reliance; and, when they closed with the enemy, he knew how to suggest the most effectual encouragement in a situation so new to them all. He appealed to the miners by their honour and spirit as Cornishmen; and, as there are few places where local pride pre-

vails so much as in the west of Cornwall, this appeal was effective. Never was an appeal made with fuller confidence, or answered with higher spirit. In the heat of the action, one of the men came from the main deck to ask the captain what he must do, "for all the men at his gun had been killed or wounded except himself; and that he had been trying to fight *alone*, but could not fight; he was willing, however, to try again if the captain ordered him." Another man who had joined but the day before, was found seated on a gun-carriage, complaining that "he had been very well as long as he had been fighting, but now, that the fighting was over, he felt very unwell. He did not know what was the matter with his leg, it smarted so much." It was found that he had received a musket-ball in his leg.

In former times, all the Cornish coast people, including miners, were *wreckers*. There is no such thing known now; but stories may be heard of former doings. One is as follows:—A certain clergyman, of no very high character, was preaching in church one Sunday morning, when a man ran in, and cried, "A wreck, a wreck!" In vain the parson entreated the patient tarrying of his audience to the close of his sermon. One by one they began to steal out, whereupon the parson suddenly closed his sermon-book, gathered up his gown, and hurried down the pulpit stairs, exclaiming aloud, "Well, well, if you will go, at least let us all *start fair!*" The parson was a wrecker, too.

In past times, too, the Cornish miners had a particular spite against excisemen. Local history and tradition retain accounts of many hair-breadth escapes of, and violent attacks upon, those detested defenders of the public treasury. Personal attacks on excisemen were generally made at night, and mistakes in identity were sometimes made, most unfortunately for the unlucky individual who looked, or rode, or walked, like the exciseman.

A gentleman of Truro was once returning late at night from Redruth, when suddenly a band of miners set upon him, knocked him off his horse, and shouted, "Nack un down, nack un down! and scut un owl abroad 'pon the planshain." The assailed gentleman speedily undeceived them, when, with all the eloquent tones of genuine repentance, they exclaimed, "Arreah, Measter S——

es ut? Who, we wudn't hurt a hier av hes heed." They remounted Measter S——, and escorted him far on his way, finally taking leave of him with renewed apologies.

HEROISM IN A MINE.

I prefer to give this incident in the words of Thomas Carlyle, (*Life of Sterling*, p. 278.) "In a certain Cornish mine, said the newspaper duly specifying it, two miners deep down in the shaft were engaged in putting in a shot for blasting; they had completed their affair, and were about to give the signal for being hoisted up. One at a time was all their coadjutor at the top could manage, and the second was to kindle the match, and then mount with all speed. Now it chanced, while they were still below, one of them thought the match too long, tried to break it shorter, took a couple of stones, a flat and a sharp, to cut it shorter, did cut it off the due length, but, horrible to relate, kindled it at the same time, and both were still below! Both shouted vehemently to the coadjutor at the windlass, both sprang at the basket; the windlass man could not move it with them both! Here was a moment for poor miner Jack and miner Will! Instant horrible death hangs over both, when Will generously resigns himself. 'Go aloft, Jack, and sit down; away! in one minute I shall be in heaven!' Jack bounds aloft, the explosion instantly follows, bruises his face as he looks over, he is safe above ground; and poor Will? Descending eagerly, they find poor Will too, as if by miracle, buried under rocks which had arched themselves over him, and little injured; he too is brought up safe, and all ends joyfully say the newspapers.

"Such a piece of manful promptitude, and salutary human heroism, was worth investigating. It was investigated; and found to be accurate to the letter, with this addition and explanation, that Will, an honest, ignorant, good man, entirely given up to Methodism, had been perfect in the 'faith of assurance,' certain that *he* should get to heaven if he died, certain that Jack would not, which had been the ground of his decision in that

great moment; for the rest, that he much wished to learn reading and writing, and find some way of life above ground instead of below. By aid of the Misses Fox, and the rest of that family, a subscription (modest *Anti*-Hudson testimonial) was raised to this Methodist hero; he emerged into daylight with fifty pounds in his pocket, did strenuously try, for certain months, to learn reading and writing; found he could not learn those arts, or either of them; took his money and bought cows with it, wedding at the same time some likely milkmaid."

I have purposely omitted a concluding sneer of Mr. Carlyle's at the miner's religion. For myself, I should envy the man that faith of assurance which could support him in such an extremity, in such a place, unwitnessed, unapplauded, ready to make a sacrifice of life on the highest principle. Can Mr. Carlyle find such another hero in human life in all his Hero-Worship?

Contrast the case of the very man in whose biography this anecdote is introduced with that of the miner. Poor Sterling! with all his philosophy he would scarcely have stood in the place of the heroic miner. No! in the scale of moral heroism Sterling stands below the Cornish miner.

I could narrate instances of manly self-denial amongst the better orders of the miners, which would be an honour to the highest-minded men in the country. I append an extract from a Methodist preacher's account, which will give an instance of more quiet and yet really high-principled feeling, in a Cornish miner. The Methodist remarks:—"A nobler set of men (alluding to some Methodist miners) I never met with in my life, and such was the impression of my friend who visited them before I went down. They are as generous, warm-hearted, and devoted a people as you could possibly desire to see. I met down there with one of the most striking developments of pure, disinterested, brotherly, Christian affection I ever witnessed. There is a local preacher in the Camborne circuit named Thomas Samson; and a Samson he is, both in mind and body, in moral and mental, as well as in physical strength. He is a working miner, and is engaged in the bowels of the earth every day of his life, and works hard for his bread. The captain of the mine said to him

on one occasion, 'Thomas, I've got an easier berth for you, where there is comparatively little to do, and where you will earn more money than you now do; will you accept it?' What do you think he said? 'Captain, there's our poor brother So-and-so; he has a sick body, and is not able to work so hard as I am. I fear his toil will shorten his useful life. Will you let him have the berth?' The captain, pleased with his generosity, sent for the 'brother,' gave him the berth, and he is now possessing and enjoying it. Thomas added, 'I can work a little longer yet;' and when I looked him in the face, I could not help feeling that there was developed in it a fine expression of that brotherly love which, in this instance, he had displayed."

MINING SCHOOLS AND EDUCATION.

There is at present nothing specially worthy of notice in relation to the education of miners and their children, as such. There are day and night schools in the mining districts, much like those I have described as found in the northern colliery district. The Sunday schools of the Methodists, of various sects, have been useful in affording some elementary education. Much, however, still remains to be effected in this matter.

It has long been felt that a School of Mines is wanted in Cornwall, and Sir Charles Lemon and others have, on several occasions, done their best to establish and encourage such a school. All such attempts have, however, hitherto been abortive; but it is to be hoped that a School of Mines will now really be established in Cornwall, for the project is being seriously taken up at the time I am writing. The object of the promoters is to establish a central School of Mines at Truro—at an estimated cost to the county of about £1000 per annum, which amount is to be raised by subscription. The requisite number of teachers is to be provided at suitable salaries, which expense Government has undertaken to defray for the first three years. The course of instruction is to extend over two years, and to be divided

to two appropriate sections. A museum and library will be tached to the Central Institution. Elementary courses of ctures are to be given at a very low charge to working men, ot only in the mining schools, but also in the several mining stricts. As considerable local influence is engaged in this proct, it bids fair to be at least tried, and so far realized. The reat difficulty will be to secure the requisite funds for carrying n this institution after the first three or four years, when the ovelty will have subsided. It is to be hoped that those for hom these benefits are to be provided, will be prompt in availing hemselves of them.

It is understood that a meeting of the projectors will be held n Truro on the 11th January, 1854, and that they will afterwards be prepared to lay some definite plan before those interested, and the public.

I believe it will not now be considered that, in making the following remarks, I allude improperly to the reasons of the failure of the preceding attempt to found a school of mines in Cornwall. It is known that the principal projector wished to introduce a clerical element into the establishment, and that this proposition was distasteful to many in Cornwall, in consideration of the fact, that nine-tenths of the miners are Wesleyans, or Methodists of some sect. It is much to be desired that the projected school now in view may in all respects be free from any religious or political bias. Nothing will be more fatal to its success than the discovery of any such elements in the government or constitution of the establishment. Sir Charles Lemon sustained almost the whole cost of the former educational experiment, and proposed to endow an institution with £10,000, or even £20,000, if his views were accomplished, and if a tax were levied of half a farthing in the pound sterling of value on all metallic minerals during twelve years. A majority of the adventurers opposed this tax, and Sir Charles Lemon's offer was withdrawn.

In "Our Coal Fields" I have spoken of the establishment of the University at Durham, which opened a class for instruction in civil and mining engineering in January, 1838.

EXAMPLES OF INTELLIGENCE AMONGST MINERS.

Amongst the engineers of England now or recently employed in the construction of railways, canals, and bridges, and other important works, are several able and somewhat eminent men, who began their career as working miners. Not only have we had George Stephenson from the northern coal mines (see "Our Coal Fields," p. 228), &c., but we have also a living example of a man of considerable scientific attainments, who, I believe, has no false pride about him, and who will rejoice to find that his example may be influential to others. I refer to James Hann, Esq., professor of mathematics (or engineering) in King's College School, London, the author of "Mechanics for Practical Men;" of a Treatise on the Steam-engine; of Treatises on Analytical Geometry; Plain and Spherical Trigonometry; and of the Integral Calculus in Weale's series of rudimentary works. Mr. Hann is also the author of the mathematical portion of Weale's Treatise on Bridges, in which the investigations are of a high order, and mathematically "elegant."

James Hann was, I believe, a boy working with the late George Stephenson underground, and remembers their striking for a few pence per week's extra pay.*

In the lead mines of the north of England is found another instance of intelligence among miners in Mr. Leithart, who has printed a small treatise on the formation and filling of metallic veins, in which he has ably discussed questions connected with electrical origin. Mr. Leithart was a working miner, whose only education was at a Sunday school.

Samuel Drew, the Cornish metaphysician, may be traced back to the mines, for at eight years of age he worked as a *buddle-boy;* that is, he was employed at the surface works of a mine in stirring up the fractured deposits in the *buddles* or pits, and in keeping them in agitation until this part of the separating process was complete. This fact is narrated in that interesting

* From a private communication.

book, "The Life, Character, and Literary Labours of Samuel Drew," by his eldest son.

AN ARTIST FROM THE MINERS.

Amongst the few celebrated men who have risen from the ranks of the miners of Cornwall, may be mentioned John Opie,* the artist, who has now been dead some half a century, but has left a name still honourably remembered in English art. Opie was discovered in the tin mines of Cornwall by an equally celebrated man, Peter Pindar. Peter, or more truly Dr. Wolcot, found Opie to be rough and unpolished, but full of talent. Peter Pindar had many ways of making Opie known, and talked about him, and wrote about him, and printed about him for this purpose. He introduced persons of importance to the artist's rooms, and many of them sat for their portraits, while some few gave commissions. Opie soon became celebrated as the "Cornish Wonder," and his fame soon spread eastward of Temple Bar; so that, when Pitt and Nelson died, the "Cornish Wonder" was in the full blaze of his reputation. He therefore made money more rapidly than spendthrifts consume it, was courted by all, and became, in spite of Peter, a full Royal Academician, and, better still, a married man. And these favours he deserved, for Opie had a genius for art. He was, however, more blessed than many men of genius; for, almost as soon as he proved that he possessed genius, the world was on his side, and honours were awaiting him some fifty years since, when he died, leaving as his widow the "Amelia Opie" of thousands of admiring readers. Opie's remains were deposited in St. Paul's Cathedral, near to those of Wren; but nearer still to those of Sir Joshua Reynolds.

We are apt to speak of Opie as of one belonging to olden times; and yet, as I write these pages, his name is again before the public, by the announcement of the decease of his widow. She died on the second day of this month (December 1853), at the age of eighty-five years. Her husband was the Caravaggio of English art—he drew boldly on canvass, she sketched boldly

* Opie was the son of a carpenter at St. Agnes, near Truro, where he was born in 1761.

on paper. Perhaps their after reputations may be below their present. Indeed, already by a critical artist her husband has been called a bad Caravaggio, and his wife a bad Mrs. Inchbald.

SUNDAY AND RELIGION AMONGST THE CORNISH MINERS.

I gave some account in "Our Coal Fields" (p. 215, &c.) of the religious views and habits of the northern pitmen, when they are in any sense religious; and I attributed to the Wesleyan Methodists most of the moral improvement existing amongst the coal miners. Much the same may be said of the Cornish miners, who are nearly all (where at all religious) Methodists, of some sect or branch of Methodism. The majority are Wesleyans; but the section of "Reformers" is gaining ground.

In the Cornish mining towns and districts, the Sunday is well observed, at least externally, and the miners and their families appear in various chapels in decent and clean dresses —and, as relates to the young women, often very showy ones. In fact there is, among the girls in this part of the country, what is often noticed in factory districts, a passion for dress on Sundays and holidays. Although the "maidens," as the miners call them, have little money at their disposal, yet they will make it go a great way in dress. A Cornish medical man observes, that he has often had cases brought under his notice, in which he has been satisfied that the health has been disordered by coarse and scanty nourishment, while the patients have presented themselves in dresses only to be procured at very considerable cost; and there is reason to fear that the provision of warm under clothing for the colder seasons is by no means correspondent with the outlay on the external garments, which may serve to increase the personal attractions of the wearers. The same love of display is shown in the wearing of thin* shoes and stockings during unsuitable weather, being a dangerous transition from the thick shoes and wrapping worn by the same persons in daily work. Girls will be girls even near the Land's End!

* Readers residing in factory and mill districts will have noticed similar propensities.

A certain peculiarity is noticeable in their bonnets, and in the manner of wearing them. In summer they are commonly large, straight, and projecting, with a long loose border, such as may afford effectual shelter from the sun. A rather amusing degree of concern for the preservation of their complexion is exhibited by some young females, who envelope their faces and throats in handkerchiefs, so as to present something of an invalidish appearance. In winter, the bonnets are generally smaller, and thrown rather back on the head. They are made of a lively-coloured material in some districts, and of straw in others. As you look over the maidens and young women thus arrayed on Sunday, you would say that many of them possess a considerable share of personal comeliness, and in the central district the features are often handsome; as they approach towards womanhood, there is an inclination to *embonpoint*. The use of hammers in dressing ores tends, perhaps, to the production of some fulness of bust; but the sedentary position necessary, gives little or no exercise to the lower limbs.

Very different is the appearance of the males who are miners underground. Their aspect is that of gravity, and their attire that of soberness; while their rather wan countenances indicate that the sun does not very often or long together shine upon them. The Sunday suit does not metamorphose them quite as much as it does the pitmen of the north, who are black on Saturday and white on Sunday; at least, white in their face, but black in their cloth. Yet the change is great from the loose woollen mining dress, thick shoes without stockings, and strong hat with a convex crown (usually weighing from one to two pounds, and affording sufficient protection to the head from blows and stones), of the working day, to the decent coat and jacket, and silk hat and leather shoes, of the Sunday. And to this change of dress must be added the change of the countenance—its composure and sobriety appearing on the Sunday, and befitting good Methodists who are "in full communion," and who have to give a faithful account of themselves at the next "class meeting."

In looking for the causes of the prevalence of religion amongst the Cornish miners, we must necessarily attribute much to the

early and zealous labours of Whitfield as well as of Wesley. In searching amongst the records of Whitfield's journeys, I find that he went from exciting scenes in Gloucestershire into the dales and districts of Cornwall, preaching most zealously in his own way to vast numbers. At first the miners received him in a somewhat rough style, but they were soon softened and much affected. On one occasion Whitfield writes—"I am just returned from near the Land's End, where thousands and thousands heard the gospel gladly. Every where the word of God has run and been glorified. Every day I have been travelling and preaching, and, could I stay one month, it might be spent to great advantage. At a place called Port-Isaac, the Redeemer's stately steps were seen indeed. At Camelford I preached with great quietness in the streets. At St. Ann's we had a very powerful season; and yesterday, at Redruth, several thousands attended, and the word was quick and powerful." Again he says—"Immediately after writing my last, I preached to many thousands at a place called Gwennap. The rain descended, but the grace of God seemed to fall like a gentle dew and sprinkling rain upon our souls. It was indeed a fine spring shower. In the evening I rode to St. Ives, and preached to many who gladly attended to hear the word. A great power seemed to accompany it. On the Lord's day I preached twice to large auditories. On Monday I preached again at Redruth, at ten in the morning, to near (as they were computed) ten thousand souls. Arrows of conviction seemed to fly fast." Once more, writing to the Countess of Huntingdon, he says—"I have been very near the Land's End, and every where souls have fled to hear the Word preached, like doves to their windows. The harvest is great, yea, very great, but the labourers are few. O that the Lord of the harvest would thrust out more labourers! Invitations are sent to me from Falmouth, but I cannot attend to them all at present. I want more tongues, more bodies, more souls for the Lord Jesus. Had I ten thousand, He should have them all." Thus did this remarkable man labour in Cornwall when all was dark there, and when men came from the mines and caverns of the earth to hear, for the first time, of the glad tidings of salvation.

It has been too much the custom to forget the labours of Whitfield in Cornwall, and to attribute all to the Wesleys and their followers.

With reference to the labours of the Wesleyans and other Methodists in Cornwall, no one can travel through the mining districts, and fully observe the miners and their habits, without fairly giving all due praise to that body of active Christians. One of the most remarkable testimonies (considering its author) of this kind which I have met with, issued from a clergyman of the Church of England, Richard Warner of Bath, who in a "Tour through Cornwall," in the autumn of 1808, observes, (p. 320,) in speaking of the improved moral condition of the Cornish miners, "You will naturally inquire *who* have been the immediate instruments of so much good, in a district so unlikely to exhibit such appearances? And I feel I am but doing justice to a class of people, much though undeservedly calumniated, when I answer—the Wesleyan Methodists.

"With a zeal that ought to put to the blush men of *higher pretensions*, those indefatigable servants of their Master have penetrated into the wilds of the mine, and unappalled by danger or difficulty, careless of abuse and derision, and inflexible in the good work they have undertaken, they have perseveringly taught, gradually reclaimed, and at length, I may almost say, completely reformed a large body of men, who, without their exertions, would probably have still been immersed in the deepest spiritual darkness, and grossest moral turpitude. The irreligious fools of the world, and the interested assertor of *exclusive establishment privileges* (the italics are Warner's), would probably consider this tribute of praise to the Wesleyan Methodists as the dotage of enthusiasm, or the cant of disaffection; but from *you* I may expect a more favourable conclusion. In *your* heart there is a corresponding chord which will vibrate with pleasure at the view of so ample an harvest of good, whoever may have been the labourers employed in sowing seed; and will be ready to bear grateful testimony to that exemplary zeal which, under the sanction of higher auspices, has been the means of producing it.

The consequence of such efforts is, that the miners (and large

numbers of other Cornish people) are much attached to Methodism. That ecclesiastical system was brought to them; they have felt its good effects, and therefore they have believed. Cornwall is one of the strongest holds of Wesleyanism, and I should be led to conjecture, that the present unhappy dispute and difference among that body of people will affect Cornwall least, and amongst the last of the places where Wesleyanism flourishes. The "Reformers" will probably advance but slowly there; for, as a miner would say, "the country is kindly" for Conference Methodism.

One of the most remarkable fruits of Methodism in Cornwall, found in any single individual, was Samuel Drew of St. Austell, originally a shoemaker, but subsequently a minister amongst the Wesleyans. Though labouring under all the difficulties of his humble origin and imperfect instruction, he asserted his natural superiority of mind, and was finally recognized and admitted amongst the chiefs of Conference. Drew was an original and acute thinker, and wrote ably on the immortality and immateriality of the human soul. I have been favoured with an autograph letter of his, in which he shows himself to be well able to write a metaphysical letter, as well as a book. The life of Drew is an interesting volume.

It should be mentioned that all the Methodists of Cornwall are not Wesleyans. Methodism, taking that term in its widest sense, includes a number of sects, who from time to time have separated from the main body, and formed themselves into different communities, distinguished respectively by some peculiarities of creed or mode. Amongst these the "Primitive Methodists" occupy a principal place, and they prosper in Cornwall. They do not command the numbers or the "respectability" (an odious term in application to religion) of the Wesleyans; but they are humble, earnest, self-denying men—much given to teetotalism, and to a fervid style of address and response in their religious worship. While at Redruth I had a very favourable opportunity of witnessing *a field-day* amongst them, in the celebration of what they term a "camp-meeting" in the morning, and a "love feast" at night, in their chapel at Redruth. Although I might

render a somewhat interesting account of these meetings, I forbear to do so, because it would involve the use of sacred terms; and I have no desire that a smile should be excited at the expense of those worthy though singular people, the Primitives of Redruth.

Near St. Daye (between Redruth and Truro), in the parish of Gwennap, is to be seen a large excavation or hollow, in the slope of a hill, capable of holding a large number of people. This is called "Wesley's Pit," from the fact of John Wesley having employed it as a scene of preaching. The numbers to whom he preached in the "pit" are, I think, greatly over-estimated. Certain it is, however, that great crowds assembled there to hear him, and the pit has derived a kind of Wesleyan sanctity from the circumstance. On Whit-Monday in each year, the Wesleyans still, I believe, assemble by thousands in the pit, and a worthy Wesleyan minister who had officiated on such an occasion, told me it was a most imposing sight to behold the multitude.

Had I space and time, several interesting particulars might be given of Methodist life amongst the truly worthy men who compose and sustain the "cause" in Cornwall. The present number of members of the Wesleyan Society in Cornwall, is 17,171. Their decrease in Cornwall since 1849, has been 1386 members. It is curious that Cornwall now contains very nearly as many members of this community as the whole of London, for the metropolis has 17,970 members, and their decrease in London since 1849, has been no less than 7647. The above figures are from authorized returns.

THE END.

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K.S.